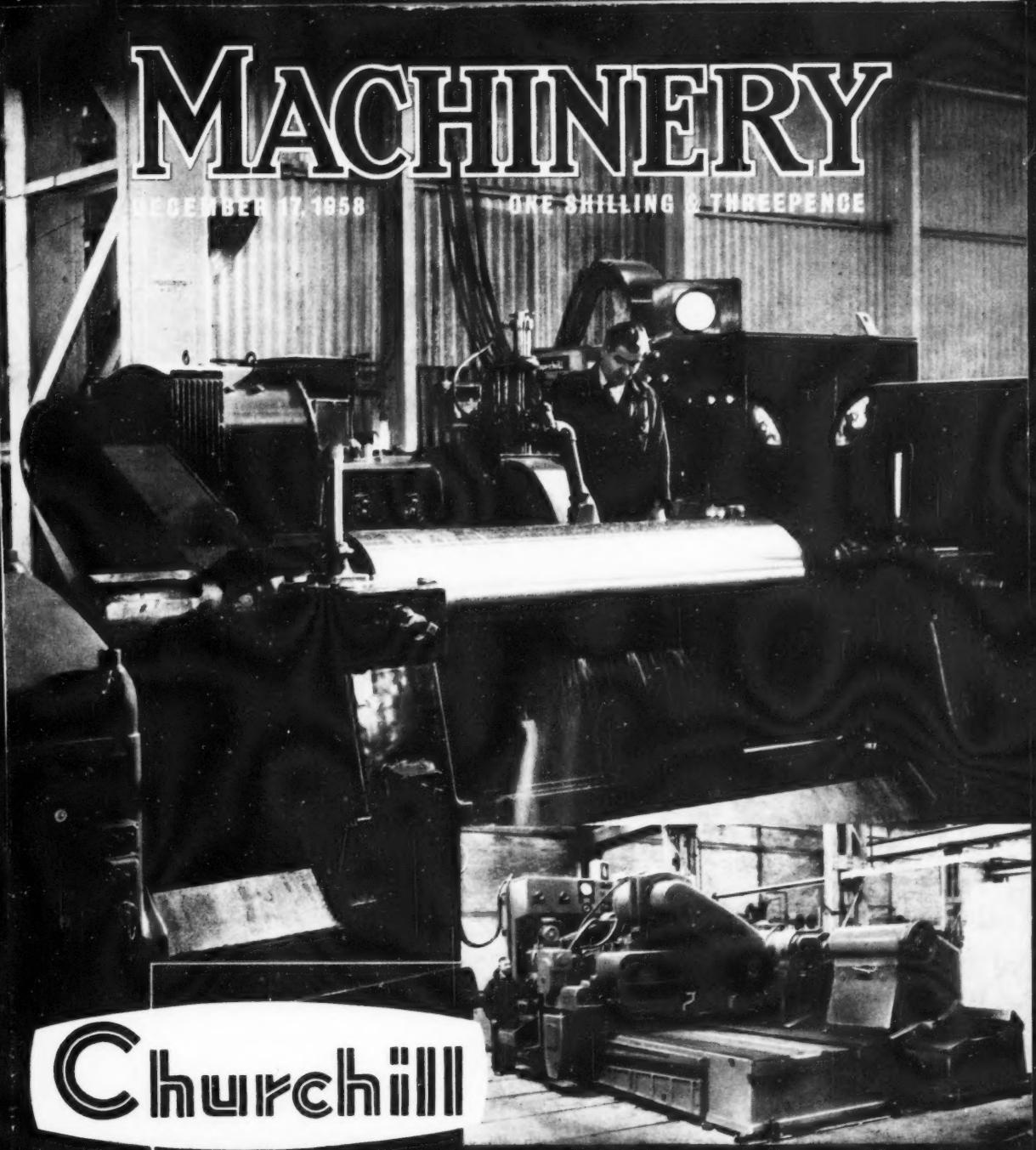
MACHINERY
DECEMBER 17, 1958 ONE SHILLING & THREEPENCE



Churchill

HEAVY DUTY ROLL GRINDER · MODEL TWB

.... grinding a cold strip mill roll 21 ins. diameter x 80 ins. face. These heavy duty Churchill traversing wheelhead Roll Grinders range from 48 ins. to 72 ins. swing and are built in lengths to suit requirements.

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fully engineered for high-output production

Asquith Units from ¼ h.p. upwards can be arranged as individual, multi-way, rotary transfer and in-line transfer machines for fast, automatic production. Some of the unit heads available are shown below. If you require large-quantity production of components at present produced on several machines, it will be worth investigating the possibility of machining them on an Asquith Unit Type Machine. Write today for details of the range of unit equipment or ask for a specialist to discuss your problem.

WILLIAM ASQUITH LTD.

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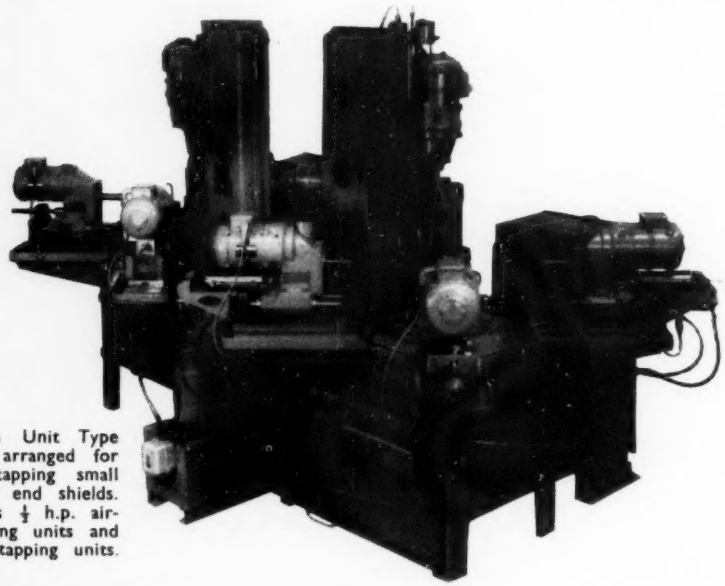
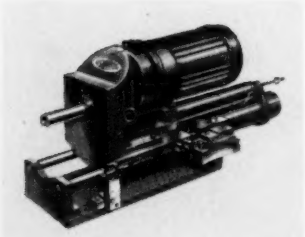
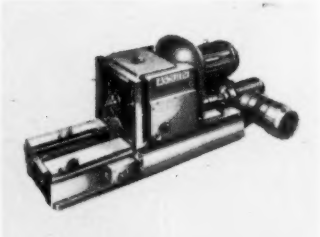


These Asquith Unit Type Machines are arranged for drilling and tapping small electric motor end shields. It incorporates ¼ h.p. air-hydraulic drilling units and ½ h.p. screw tapping units.

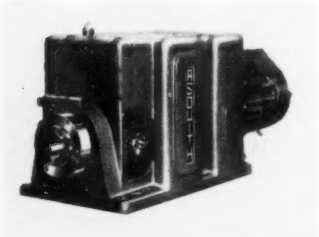
¼ h.p. AIR HYDRAULIC DRILLING UNIT



3/5 h.p. SCREW FEED UNIT



HORIZONTAL STATIC MILLING UNIT



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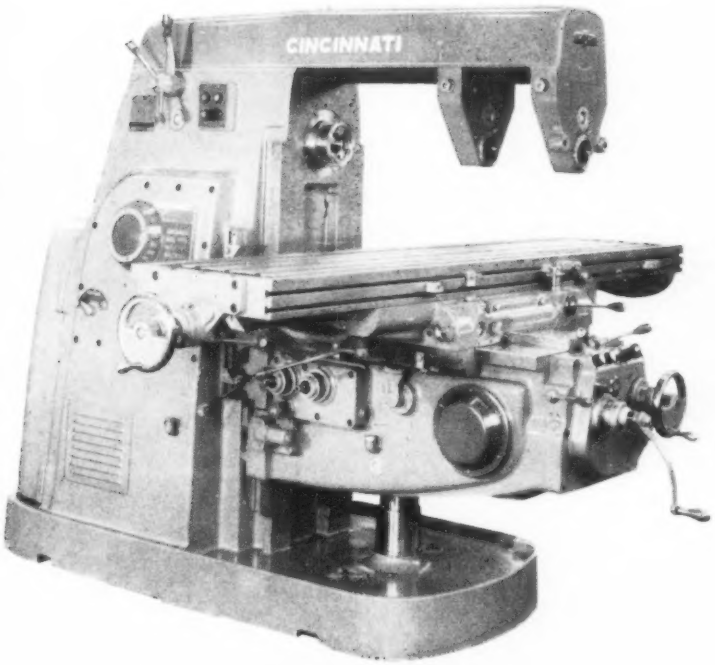

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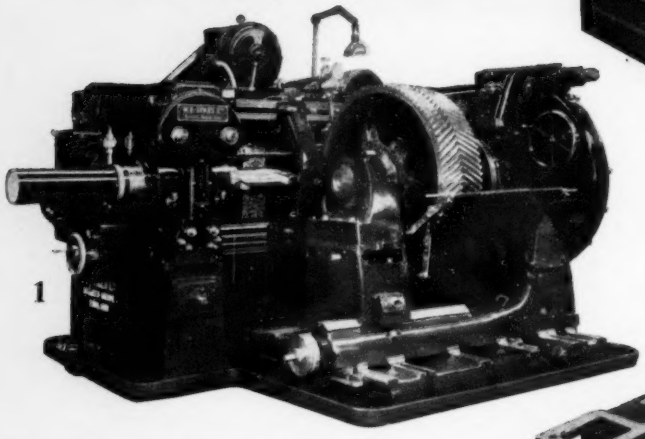

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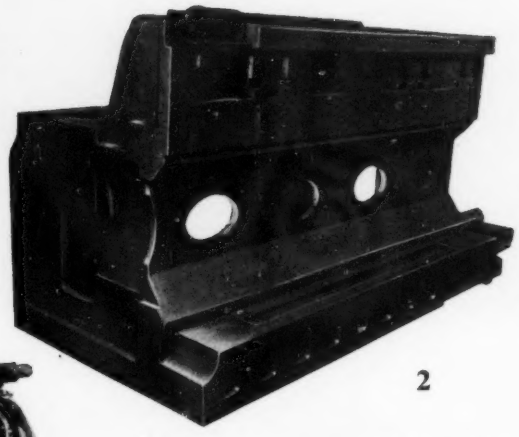


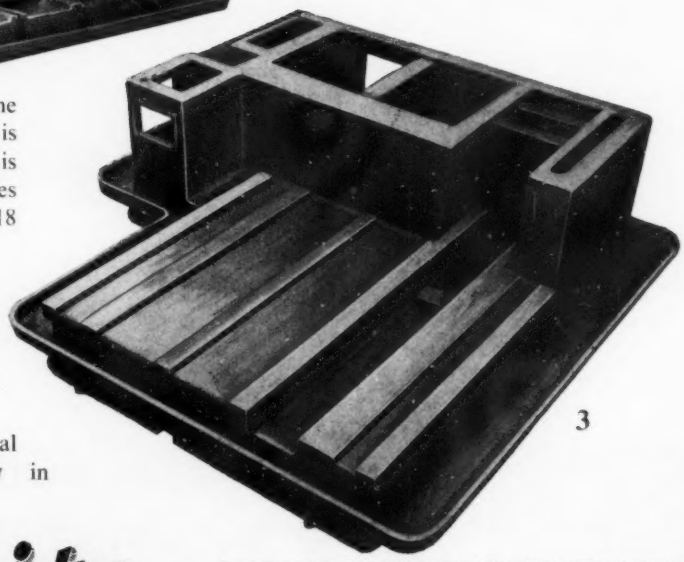
2

(1) Sykes 5E gear generating machine cutting a gear 46 in. diameter and 12 in. face width.

(2) Casting for Sykes gear generator; weight 2 tons 7 cwts.

(3) Bed for Sykes 5E machine; weight 5 tons.

The 5E horizontal gear generating machine the largest built by W. E. Sykes Ltd., is known and used all over the world. It is designed to produce gears up to 66 inches diameter and with a face width up to 18 inches. Although specifically designed for cutting double helical gears, it is admirable for cutting internal gears with straight or helical teeth. The machine tool builder appreciates the close structure and excellent machinability of Incanite which give fast and economical finishing, with consistent reliability in service.



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Long experience of chuck production has yielded the invaluable data on design, choice of materials and methods of manufacture which are incorporated in every JACOBS chuck, and upon which has been built a world-wide reputation.

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for holding and quenching heated pinions
for hardening without distortion
three individual units each of which may be operated separately

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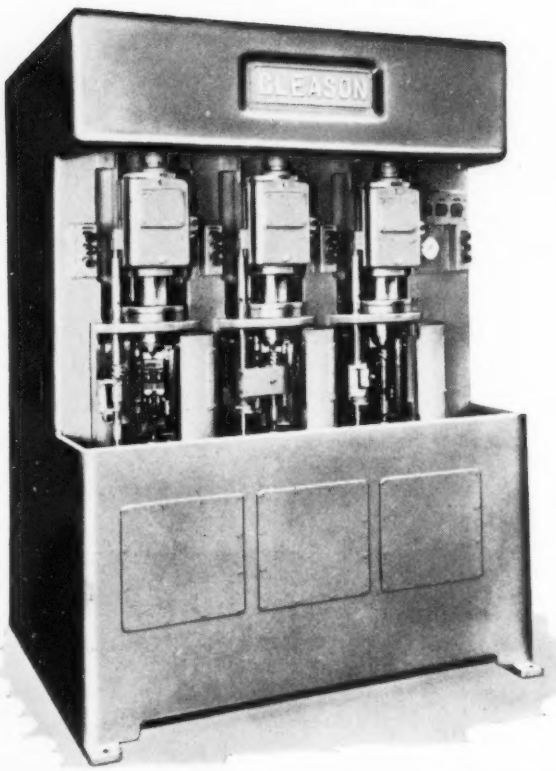

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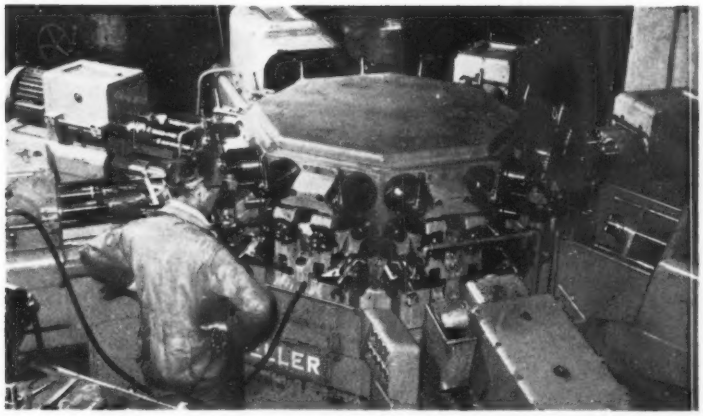
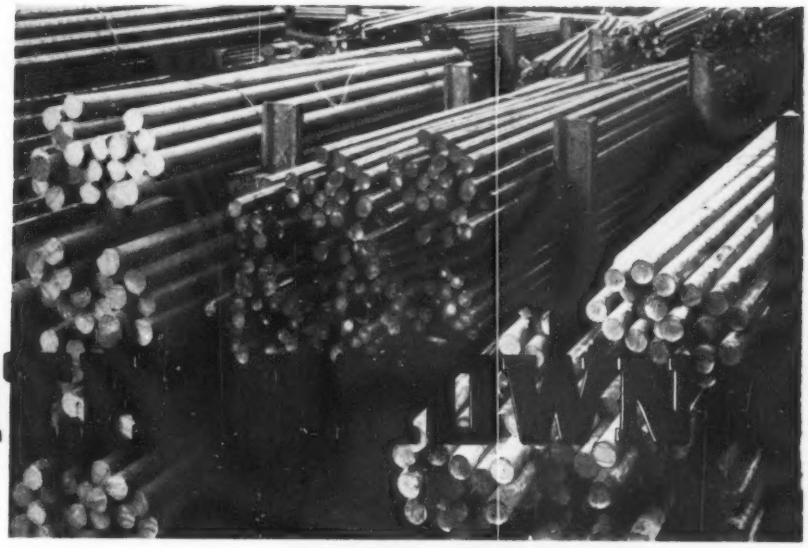


A Multi Station Indexing Machine producing Differential Pinions of the Massey-Ferguson 35 Tractor at a production time of one set of four per 100 seconds.

Photo by courtesy of The Standard Motor Co Ltd

The latest techniques in mass production ...



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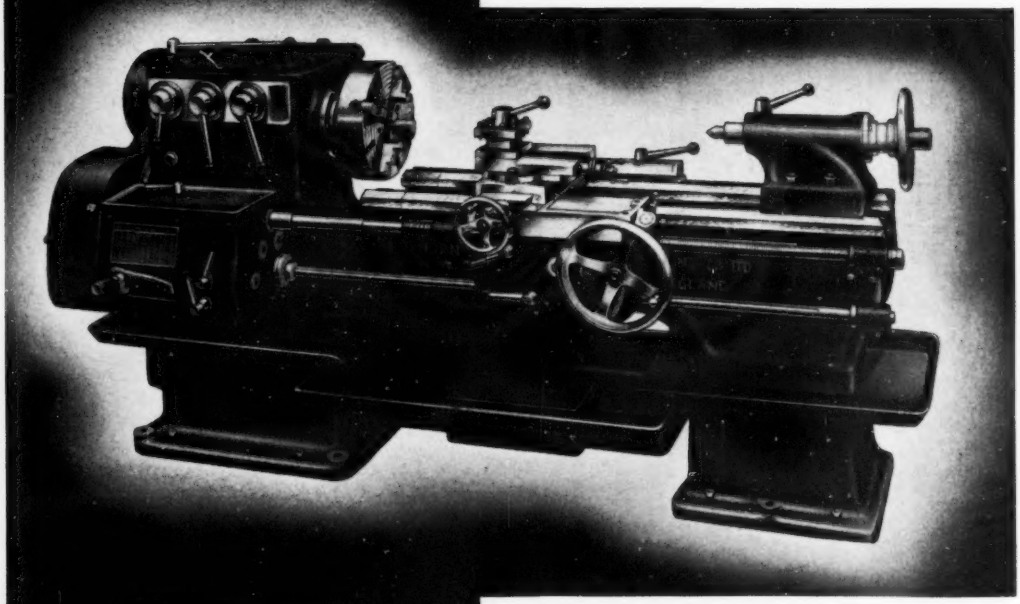

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The most popular of the Crowthorn range, these lathes include in their specification a robust vee type bed, timkenised headstock with large hollow spindle, quick change gearbox and multi-position four-way toolpost. A hexagon turret is available for either Herbert or Ward tooling equipment.

Please write for detailed literature.

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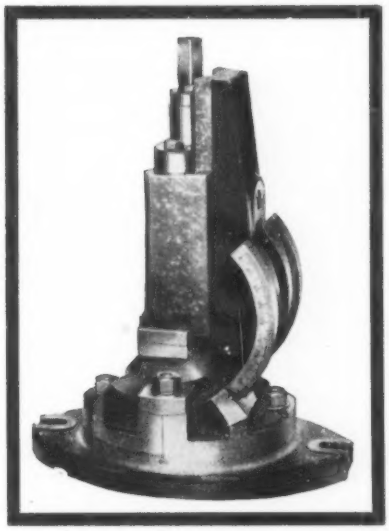

Suitable for jig boring, grinding, milling and shaping machines. Note the clean design, low height, and rigid mounting. The angle cannot alter once the clamps have been locked. Available in two sizes, 4in. and 6in. jaw widths.

This vice is accurately indexed 0-90° for angular work with spot sight and knife edge for register. The swivel base is indexed through 360° so that any combination of angles may be obtained.

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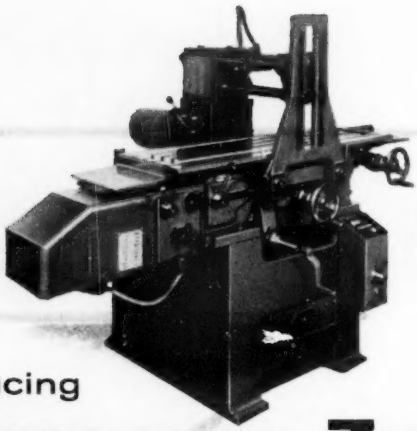

THE BIRFIELD-SOMUA Z1B

Table Working Surface	48" x 12"
12 Speeds	50–2500 rpm
Longitudinal Travel	28"
Cross Travel	10"
Vertical Travel	15¾"
Rapid Traverse	112"/min.

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BIRFIELD-SOMUA Z MILLING MACHINES

MORE RIGID
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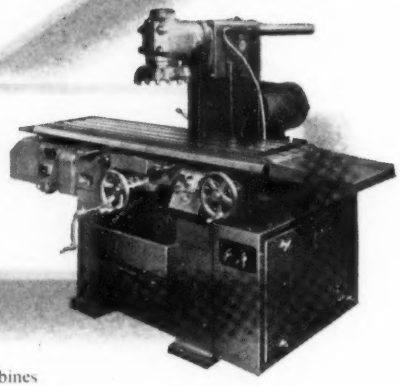

Thanks to an entirely new design concept, the Birfield-Somua Z range of milling machines combines the advantages of the bed-type machine with those of a horizontal miller.

Improved rigidity The design of the Saddle, Table, Knee, and Column forms a more compact unit nearer the machine's foundation. The distance from the cutter to the neutral axis of the machine is at a minimum so reducing distortion, vibration and chatter. Gear trains, spindles and shafts are shorter. Thus Birfield-Somua millers are more rigid, more accurate and have longer life than conventional milling machines.

More adaptable Machines are available to permit a variety of automatic cycles; of longitudinal motion, cross motion or combined longitudinal and cross motion with automatic or non-automatic returns or a continuous cycle.

The advanced design and high performance of Birfield-Somua milling machines have set new standards in industry. We shall be glad to send you full details explaining how the Birfield-Somua Z range milling machines can help *you*.

Manufactured under Saviem L.R.S. Licence.

Extra heads

These additional heads cover most milling work. A vertical head; a universal head with spindle inclinable in any direction; a slotting head (for Z1B model). A vertical swivelling head is also available for the Z3 machine.

BIRFIELD TOOLS LIMITED Bodmin Road, Coventry Tel: Walsgrave-on-Sowe 2372 a member of the **Birfield Group**

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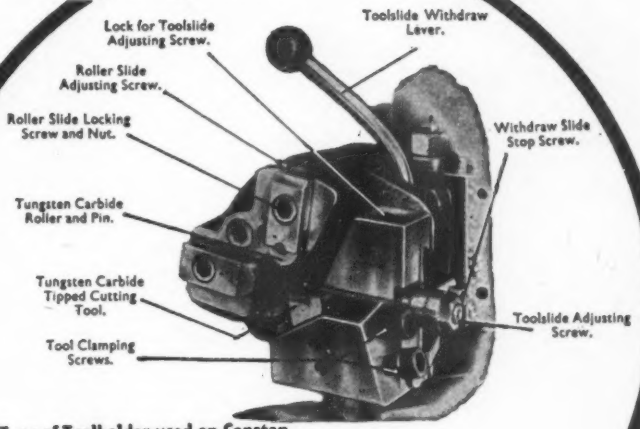
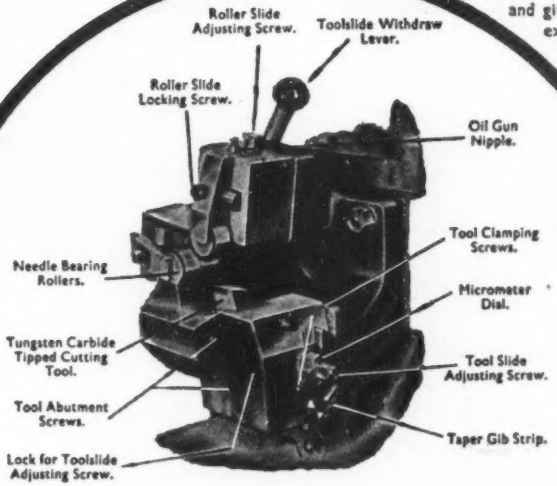
Ward

Tangential Roller Turning Toolholders


Lock for Toolslide Adjusting Screw.
Toolslide Withdraw Lever.
Roller Slide Adjusting Screw.
Roller Slide Locking Screw and Nut.
Withdraw Slide Stop Screw.
Tungsten Carbide Roller and Pin.
Tungsten Carbide Tipped Cutting Tool.
Toolslide Adjusting Screw.
Tool Clamping Screws.

Type of Toolholder used on Capstan Lathes

Toolholders for capstan lathes have long-life tungsten-carbide rollers and pins allowing maximum speeds to be used without danger of seizure and giving the work an excellent burnished finish.



Type of Toolholder for Turret Lathes

Toolholders for turret lathes have rollers mounted on anti-friction needle bearings and the roller slides have provision for oil gun lubrication.

Constructed for use with tungsten-carbide tools, these holders present the tool tangentially to the work in a quickly set robust slide having micrometer adjustment. Tool relief on return stroke obviates marking work.

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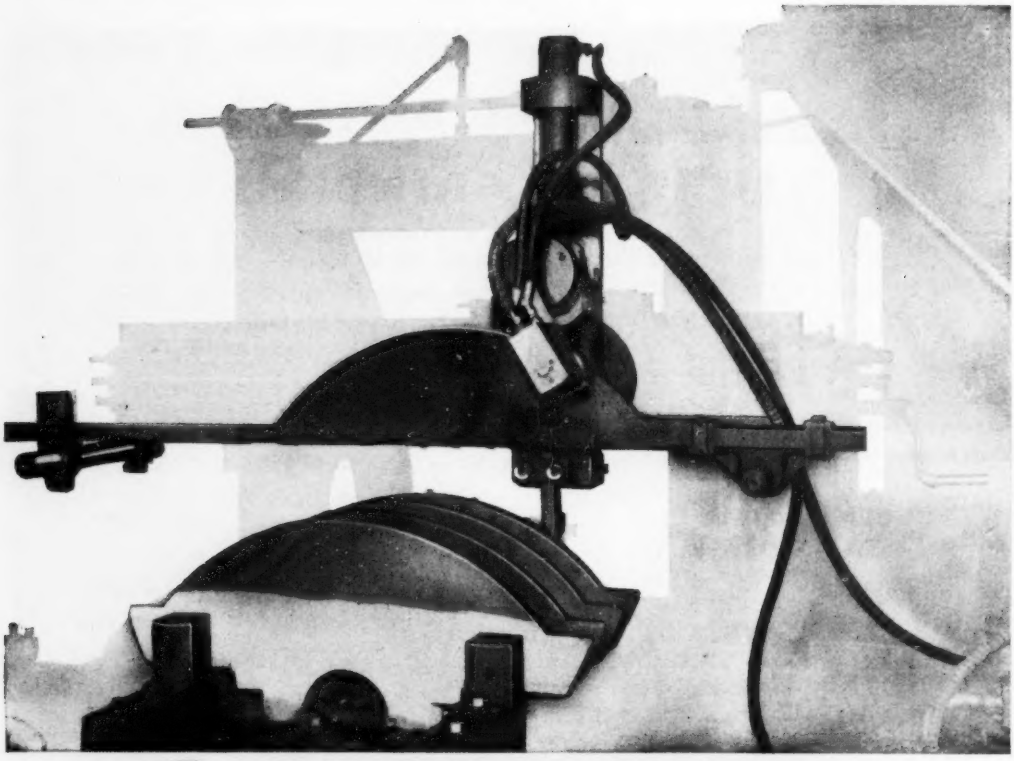

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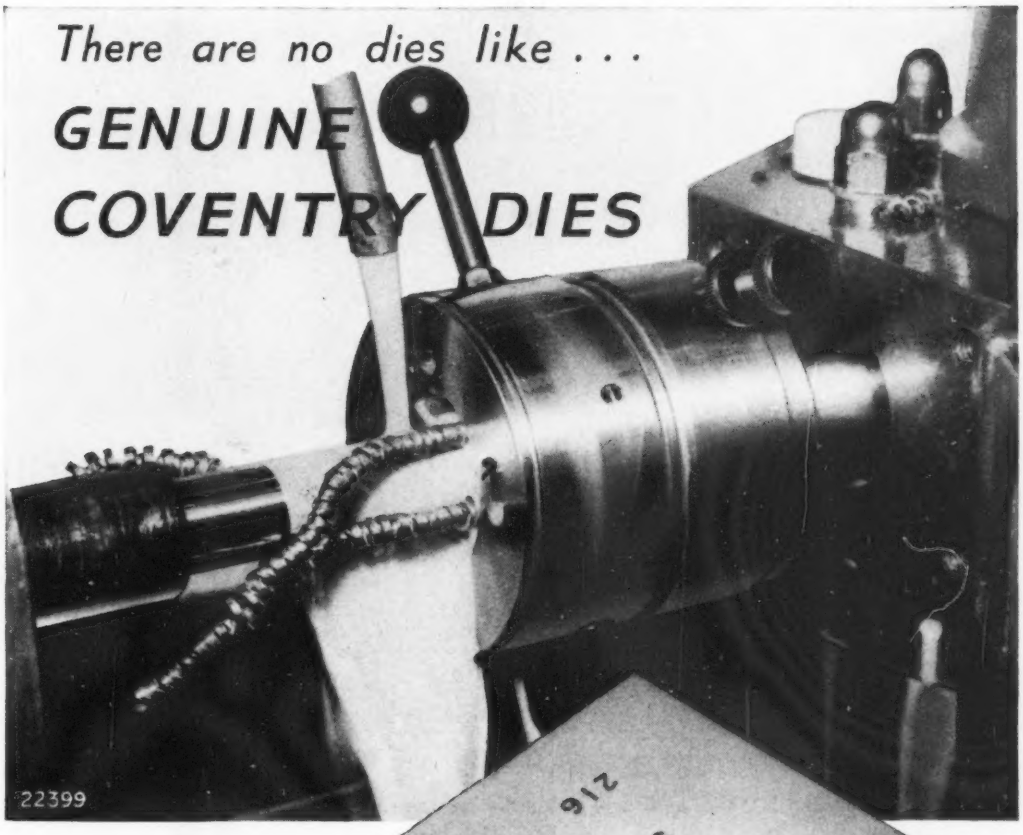

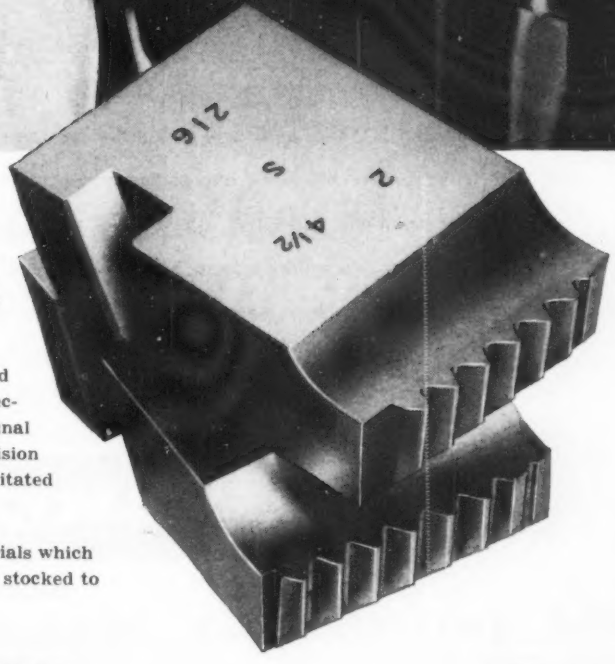

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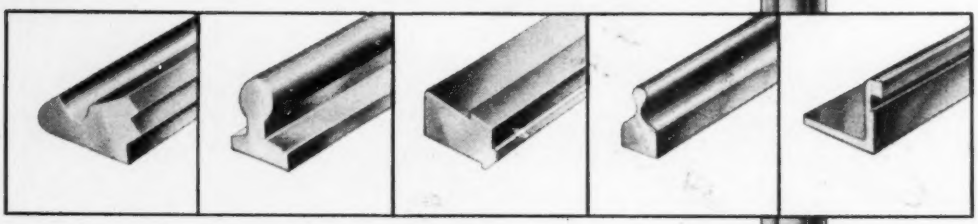

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YOU need not spend valuable time machining from the solid bar to obtain special shapes when BRUNTONS skill and resources are available. BRUNTONS have over 50 years' experience in the production of BRIGHT DRAWN SPECIAL SECTIONS to customers' requirements, in mild medium and high carbon steel, stainless iron and steel and other alloys. Accuracy guaranteed within close limits.

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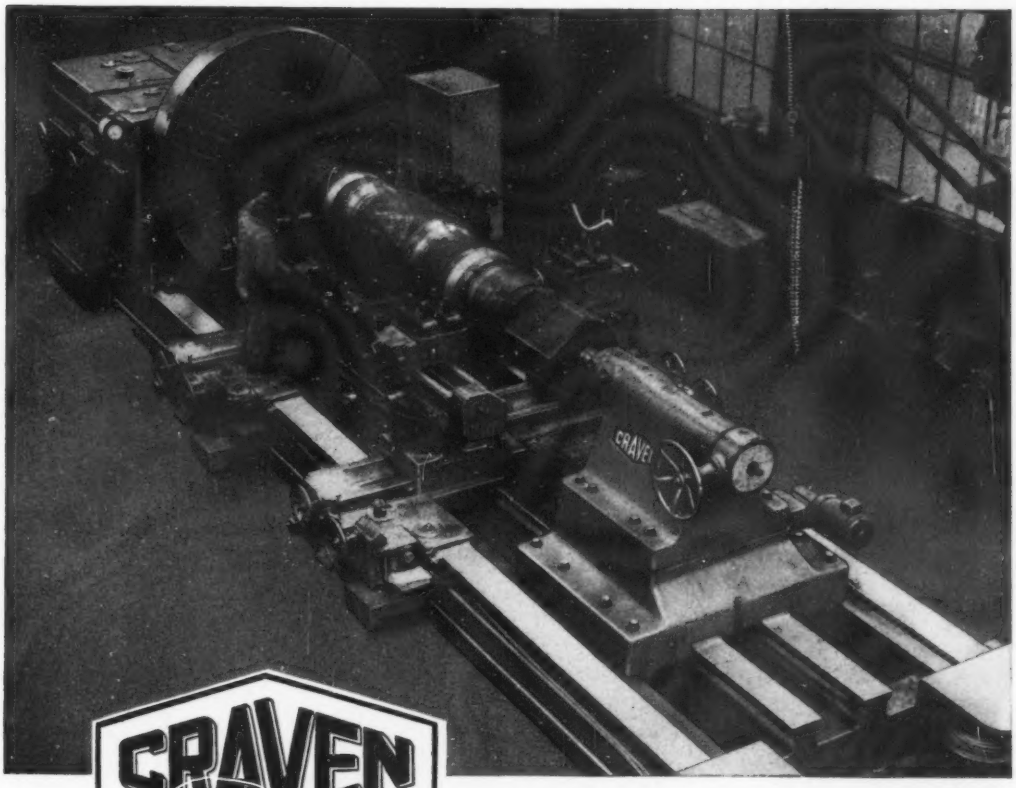

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There is a standard or special " Craven " Lathe for every large capacity or heavy duty turning requirement, a wide range of alternative arrangements being available to suit different classes of work. A speciality is made of heavy roll turning lathes and large diesel engine crankshaft lathes, whilst the " break " type of lathe construction is gaining popularity among marine engineers. The " Craven " range includes also high-speed tube boring machines and railway wheel and axle lathes of all types.

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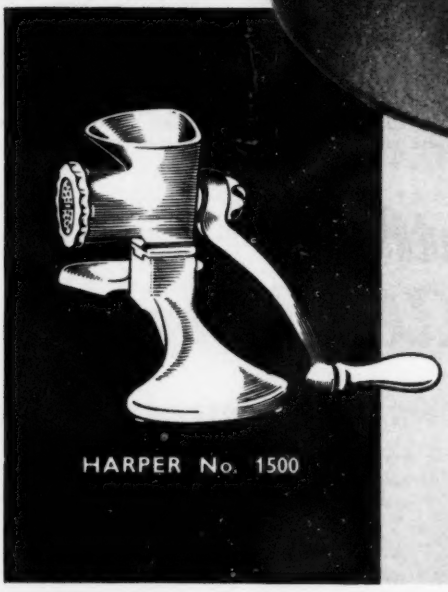
with excellent finish which can be vitreous enamelled direct



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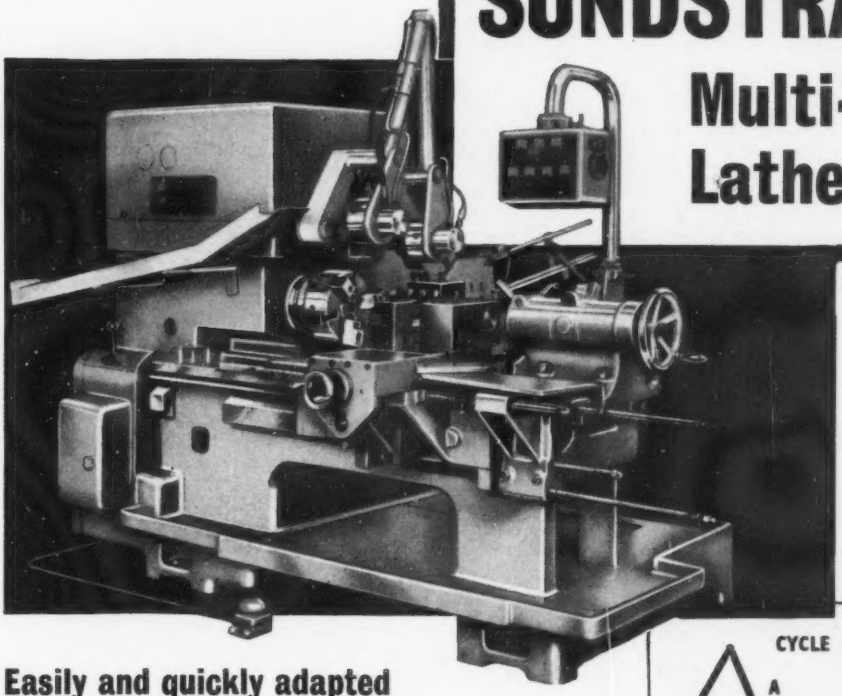

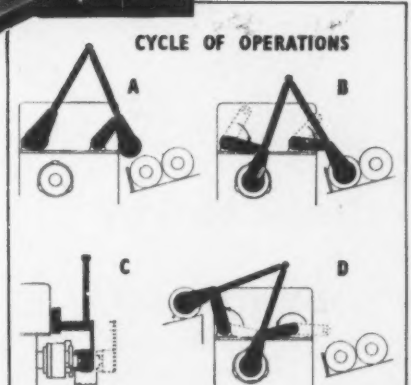

Easily and quickly adapted to handle various sizes and shapes of workpieces.

The machine illustrated is fitted with an automatic loading and unloading attachment operated hydraulically from a simple control disc fitted with adjustable stops. The two arms are each fitted with hydraulically operated chucks which allow the arm on the right-hand side to pick up components from a magazine, and load them into the chuck, while the left-hand arm removes and unloads completed workpieces from the machine.

ROCKWELL MACHINE TOOL CO. LTD

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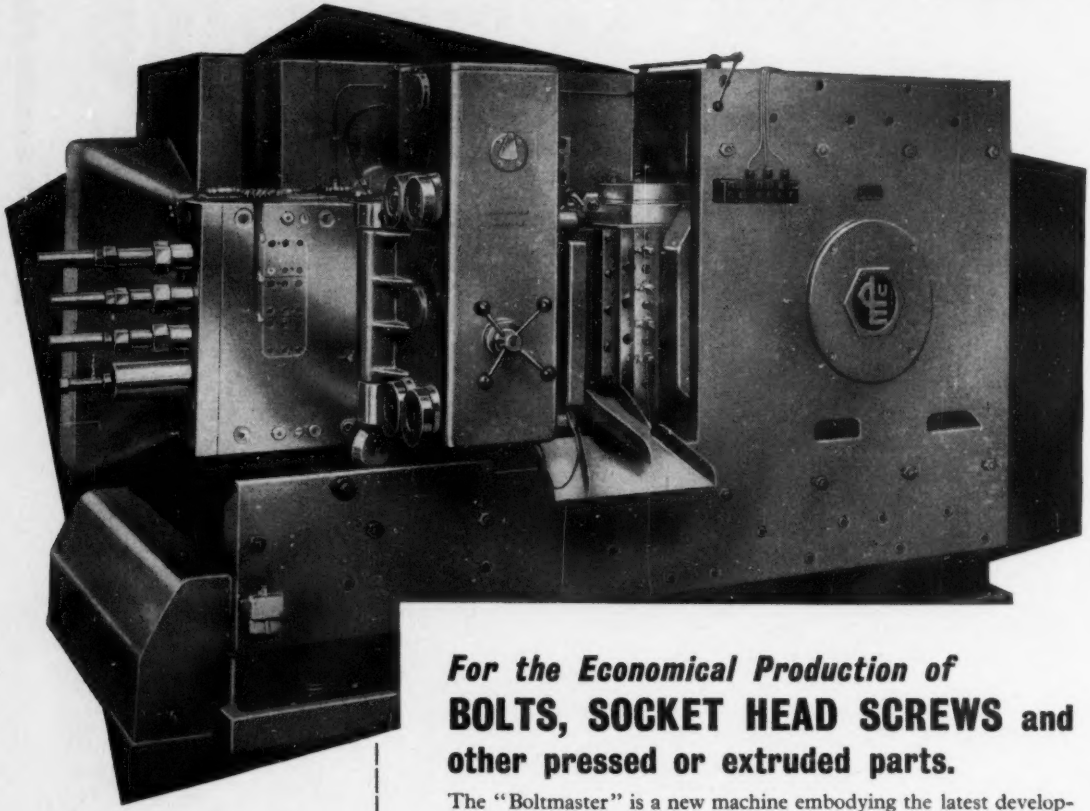
'BOLTMASTER'
COLD EXTRUSION TRANSFER PRESS



HIGH OUTPUT

LOW SET-UP TIME

For the Economical Production of
BOLTS, SOCKET HEAD SCREWS and other pressed or extruded parts.

The "Boltmaster" is a new machine embodying the latest developments in cold-forming techniques. It will pay you to investigate the possibilities of this machine.

Type	Capacity	Output/min
GB 75	up to $\frac{3}{8}$ inch	120—140
GB 100	up to $\frac{1}{2}$ inch	70—100
GB 200	up to $\frac{3}{4}$ inch	60—90
GB 300	up to 1 inch	50—80

For further particulars write or telephone TODAY

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MACHINE TOOL CO. LTD.

WELSH HARP, EDGWARE RD., LONDON, N.W.2. TEL: GLADSTONE 0033

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ELECTRIC SUDS PUMPS
for machine tools

Of proved design and sturdy construction, BTH suds pumps meet amply the most exacting requirements for continuous supply of coolant to the tool's cutting edge.

There is only one shaft; this carries the electrical rotor at the top and the impeller (which must be immersed in the coolant) at the bottom. The complete rotor assembly is dynamically balanced, and liberal impeller clearances ensure freedom from mechanical trouble should chippings enter the screened inlet.

Pumps are available for all standard A.C. voltages, and for outputs ranging from 5 gallons per minute at 7-foot head to 32 gallons per minute at 10-foot head when pumping suds; modified units can be supplied for pumping oil.

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THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND

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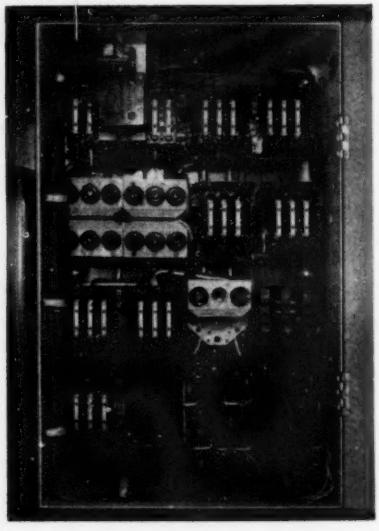
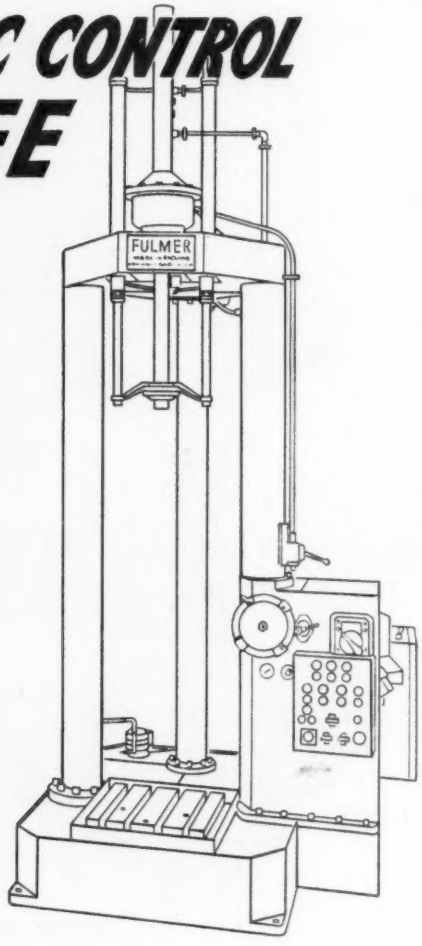
The Fulmer Honing Machine

FULLY AUTOMATIC CONTROL by CRABTREE

To ensure perfection of control the manufacturers of this Honing Machine, Messrs. Purfection Engineering Co. (Coleshill) Ltd., Birmingham, unhesitatingly chose Crabtree fully automatic control gear for their equipment.





The control panel embodies: 1 reversing starter, 3 direct-on starters, 2 contactors, 15 H.B.C. fuses and a 50 amp. isolating switch.

J. A. CRABTREE & CO. LTD., LINCOLN WORKS, WALSALL, STAFFS.

'Crabtree' (Registered)

C.786 Advt. of J. A. Crabtree & Co. Ltd., Walsall, Staffs.

... British-Built

FULMER

HONING MACHINES

—Unsurpassed for precision with stock removal up to 1-2 cubic inches per minute.

AUTOMATIC FEED

RUGGED—RELIABLE—Automatic sizing or timed cycle on Open End—Blind End—Ported, Slotted or Shouldered Holes.

FULMER honing machines entirely eliminate the need for fine boring. The most economical production is obtained by ROUGH boring within 0·012in. to 0·015in. of finished sizes and then FULMER honing.

STANDARD SIZE RANGE
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STROKE 15in. TO 15ft.
HORSE POWERS from 5-65

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STATION ROAD · COLESHILL · WARWICKSHIRE
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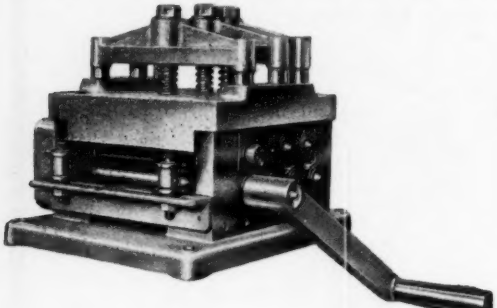
for strip up to 6″ wide
Quick release, controlled oil feed

SELF-CENTRING HUB
for motorised coilholders
Types M.1., M.4., M.L.20. and M.I.1



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STRAIGHTENING ROLLS
H.C.B.6. for strip up to 6″ wide
and ·020″ to ·080″ thick

Full details from the makers

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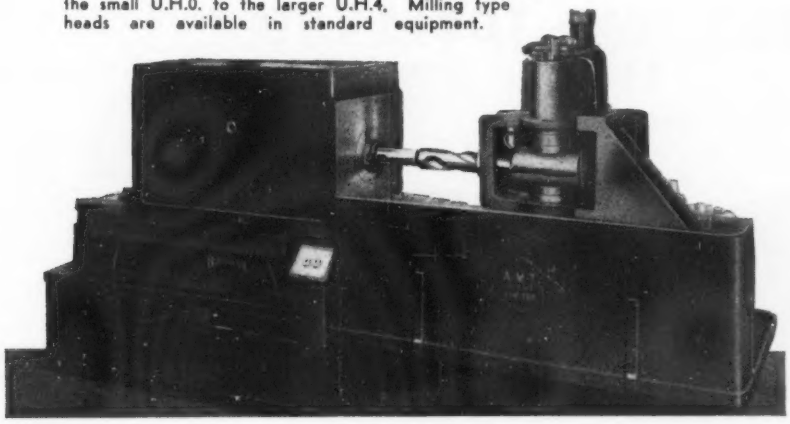
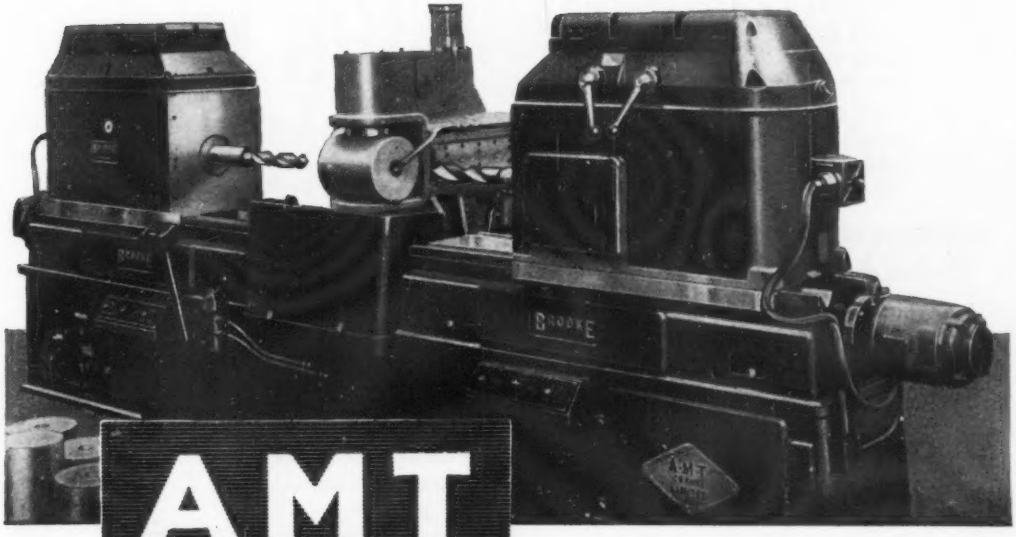


Single and Double ended
BILLET DRILLING MACHINES



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Lengthening tool life, reducing wear and providing healthy working conditions.

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MAGNETIC COOLANT SEPARATORS 5 to 103 gallons per minute capacity

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- Designed for machine tools, rolling mills, etc.
- 100% sludge, abrasive and swarf collection.
- Economical in use—the Kleenall is a real investment.
- 11,000 Barnesdril units in world wide service.
- Clean coolant is essential in modern mills and machines.

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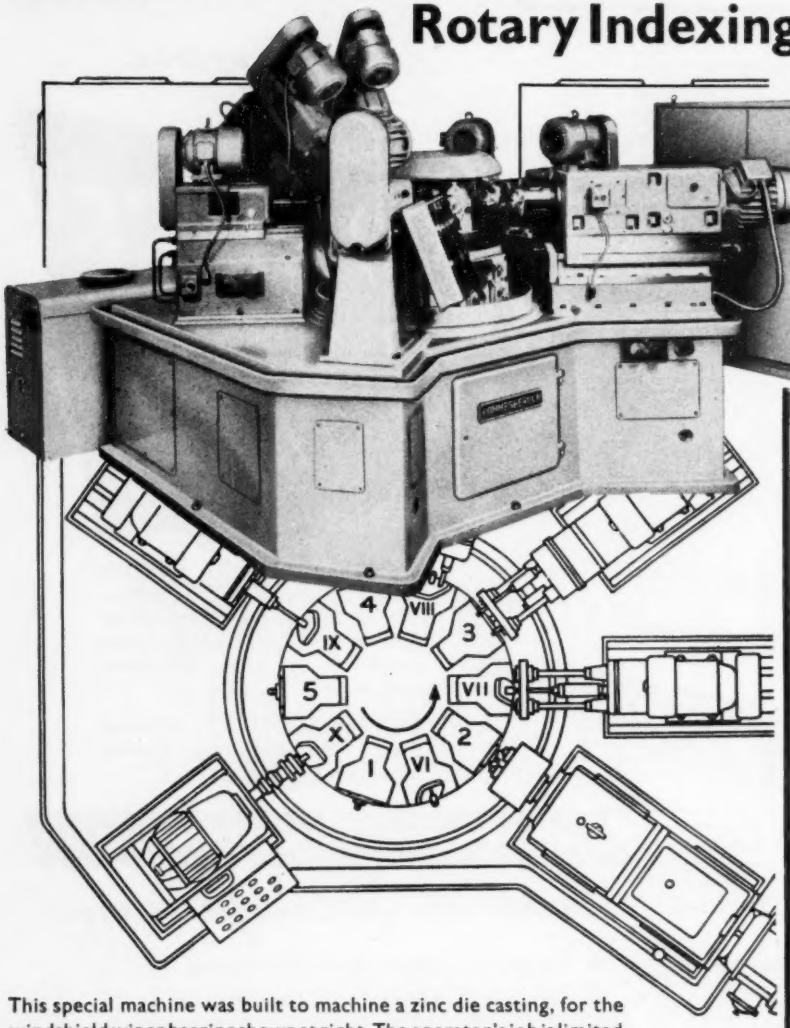
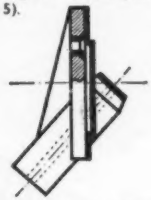
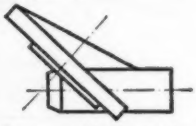
Rotary Indexing Machine



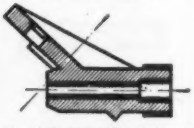
Casting loaded for machining during 1st rotation (stations 1 - 5).



Parts shown after 1st rotation (faced, drilled and spotfaced end milled).



Part premachined at stations 1 - 5 loaded for stations VI - X (2nd rotation).



Finished part after 2nd rotation (step drilled, deburred, reamed, tapped).

Output: approx. 220 pieces per hr. at 85% efficiency.

This special machine was built to machine a zinc die casting, for the windshield wiper bearing shown at right. The operator's job is limited to loading, reclamping and unloading of these parts. The machine is built up of three single-spindle drilling units, two slide units with built-on 2-spindle drilling heads, one facing unit with hydraulic shuttle table, one tapping unit and one hydraulic rotary indexing table.

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NETTLEFOLD & MOSER
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'Mills' Bright Super Freecutting Steel to Spec. EN.I.A.: rounds, hexagons.
'Mills' Bright Steel to EN Specifications.
Aluminium Sheets.
Brass Bars & Flats.
Black Mild Steel: rounds, squares, flats, strip, hoops, angles, channels, tees.
Crown Wrought Iron: rounds, flats, squares, half rounds.
Sheets: Black: Cold Reduced General Purpose and Oiled, Hot Rolled Strip Mill, C.R.C.A.P.F.
Galvanised: "Galvatite", "Speltafast", C.R.C.A.P.F., Corrugated.
Steel Plates.
Nettlefold & Moser Limited are main stockholding agents for Exors of James Mills Limited (Bright Steels) and United Wire Works (Birmingham) Limited (Brass Bars & Flats).

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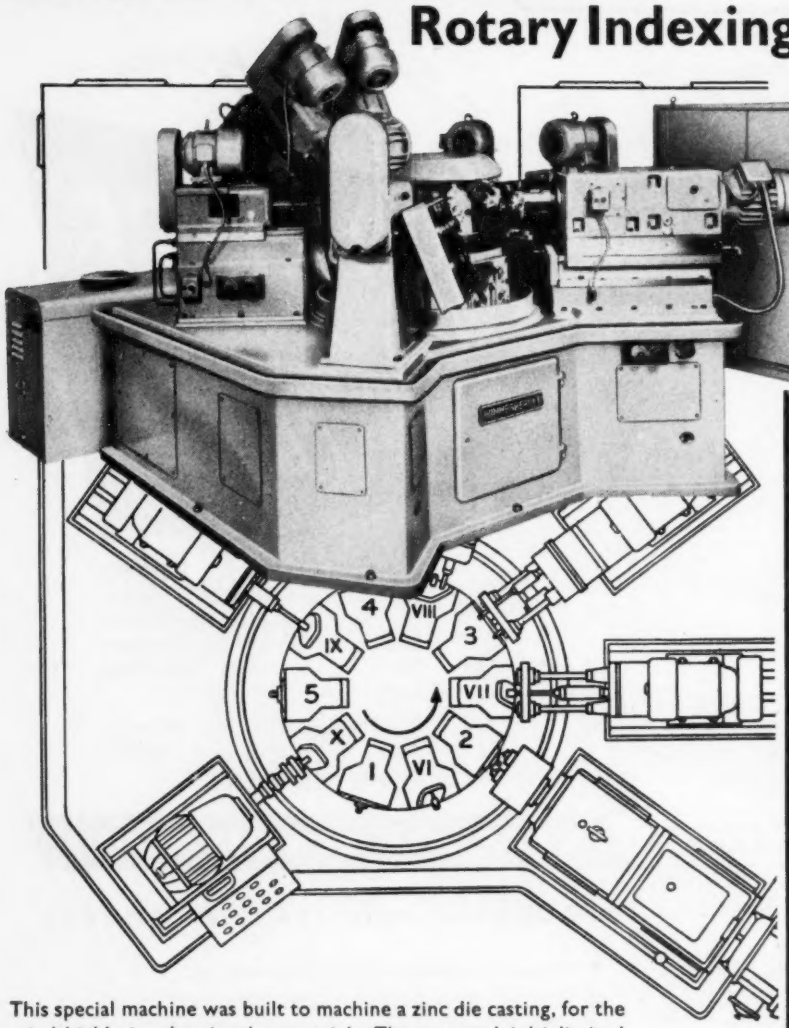
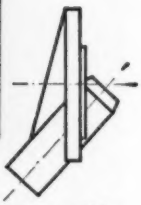
C

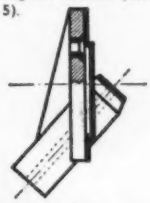
BAMMESBERGER

Rotary Indexing Machine

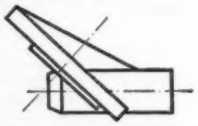




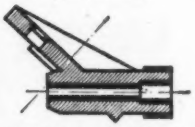
Casting loaded for machining during 1st rotation (stations 1 - 5).



Parts shown after 1st rotation (faced, drilled and spotfaced end milled).



Part premachined at stations 1 - 5 loaded for stations VI - X (2nd rotation).



Finished part after 2nd rotation (step drilled, deburred, reamed, tapped).

Output: approx. 220 pieces per hr. at 85% efficiency.

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Sheets: Black: Cold Reduced General Purpose and Oiled, Hot Rolled Strip Mill, C.R.C.A.P.F.

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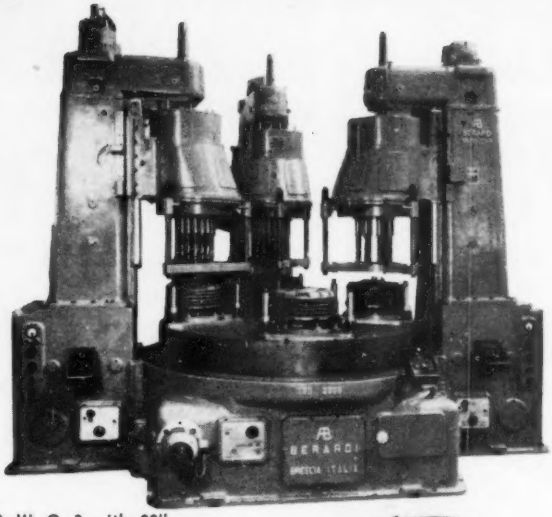
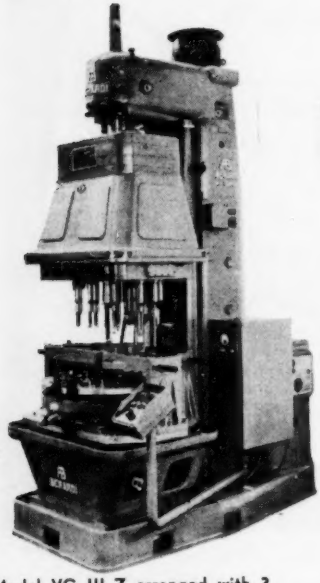
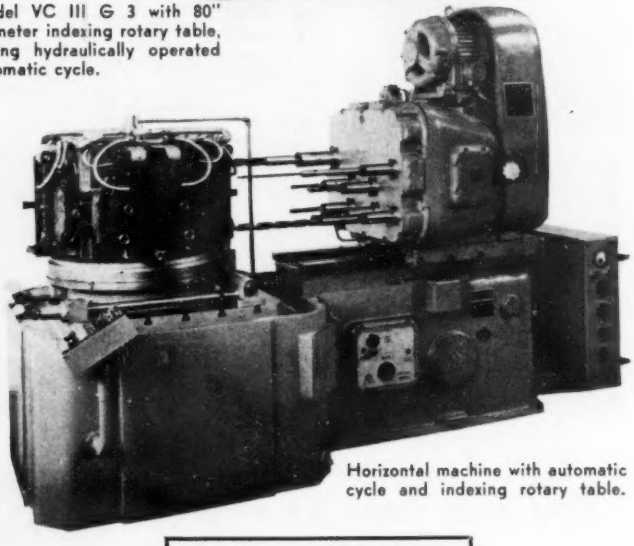


Model VC III G 3 with 80" diameter indexing rotary table, having hydraulically operated automatic cycle.



Model VC III Z arranged with 3 station automatic indexing table.



Horizontal machine with automatic cycle and indexing rotary table.

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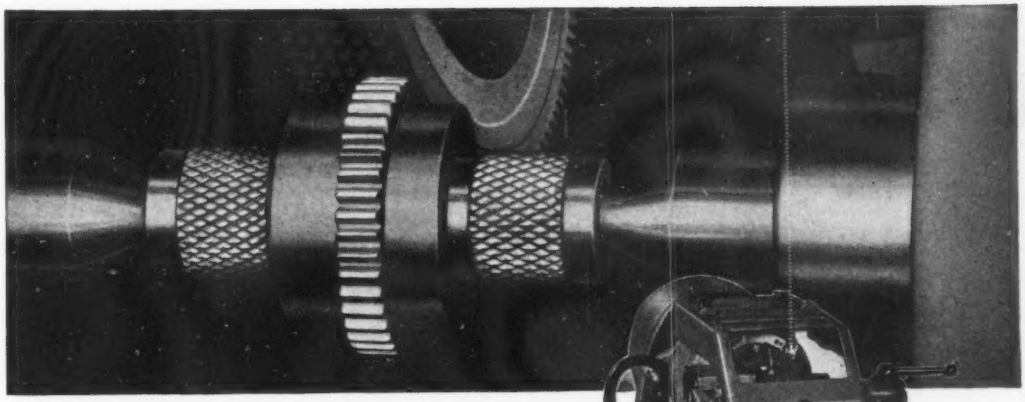

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The VS4A, once loaded, will rapidly and automatically perform a full cycle of operation varying from 13 to 45 seconds—depending on the material and characteristics of the component.

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highest accuracy, best surface finish and quietest operation is achieved by gears which have been shaved. If the fine pitch gears you produce have a total composite error of more than 0.0003 inches, you should find out more about the VS4A.

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Sykes Machine & Gear Corpn., Newark, N.J., U.S.A.
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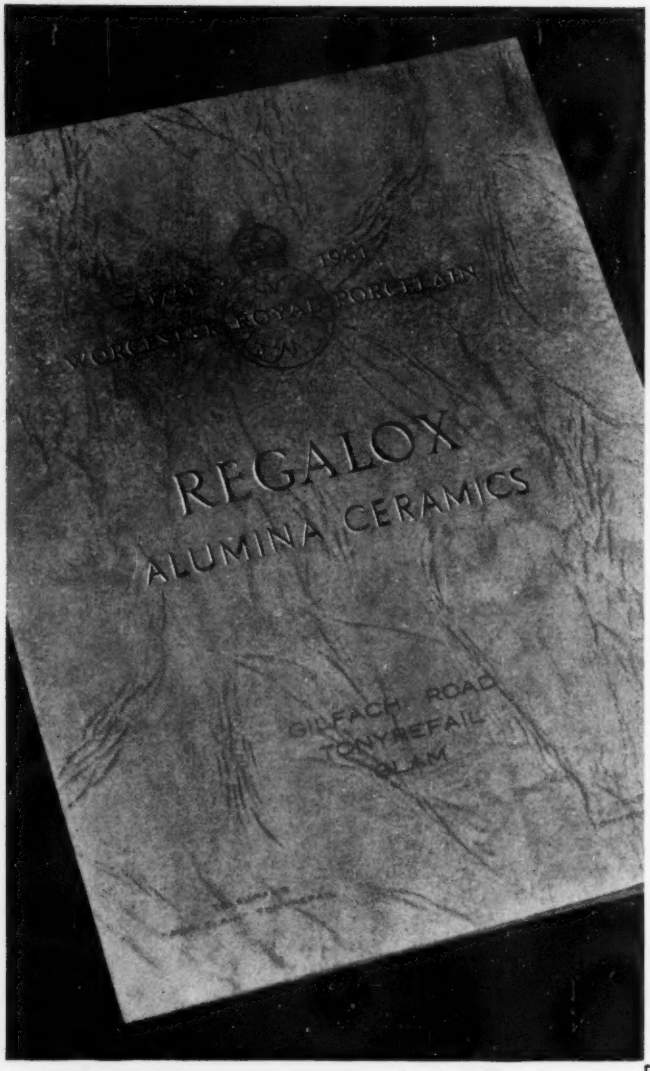

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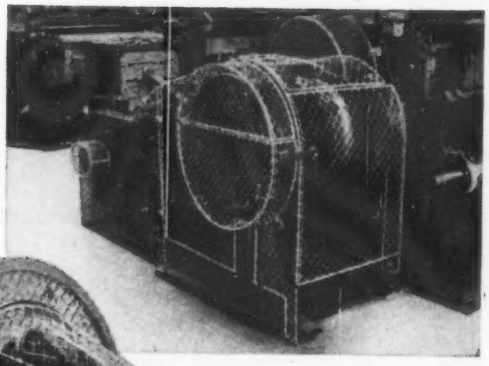
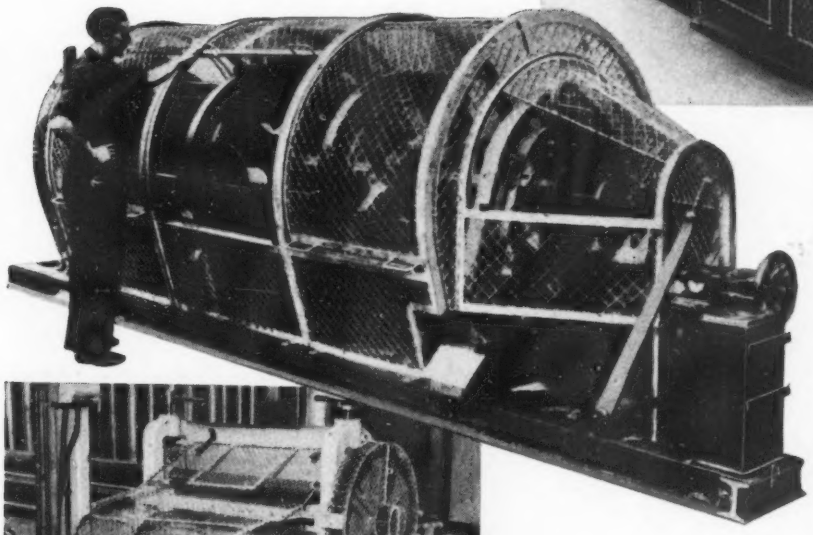
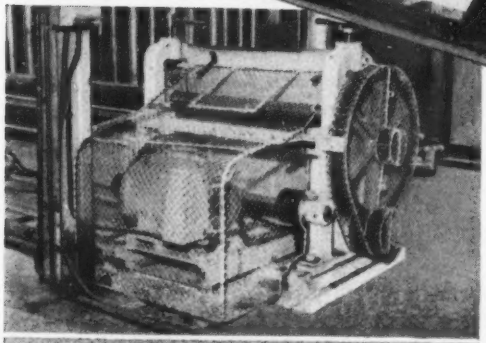
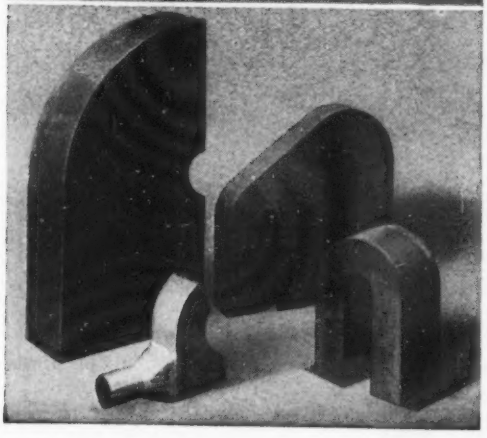




In Wirework or Sheet Metal





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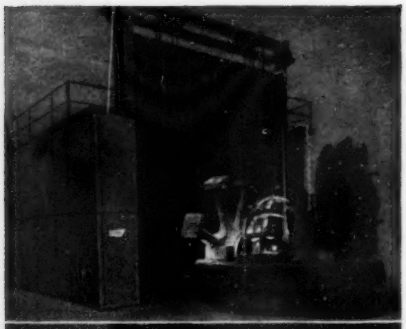
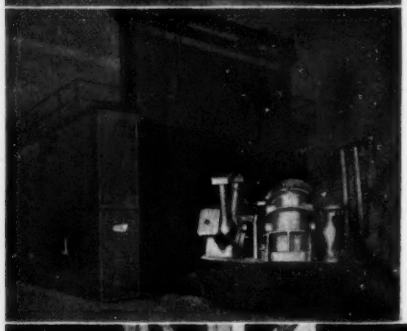
G. A. HARVEY & CO. (LONDON) LTD.
WOOLWICH ROAD, LONDON, S.E.7
Telephone: GREenwich 3232 (22 lines)





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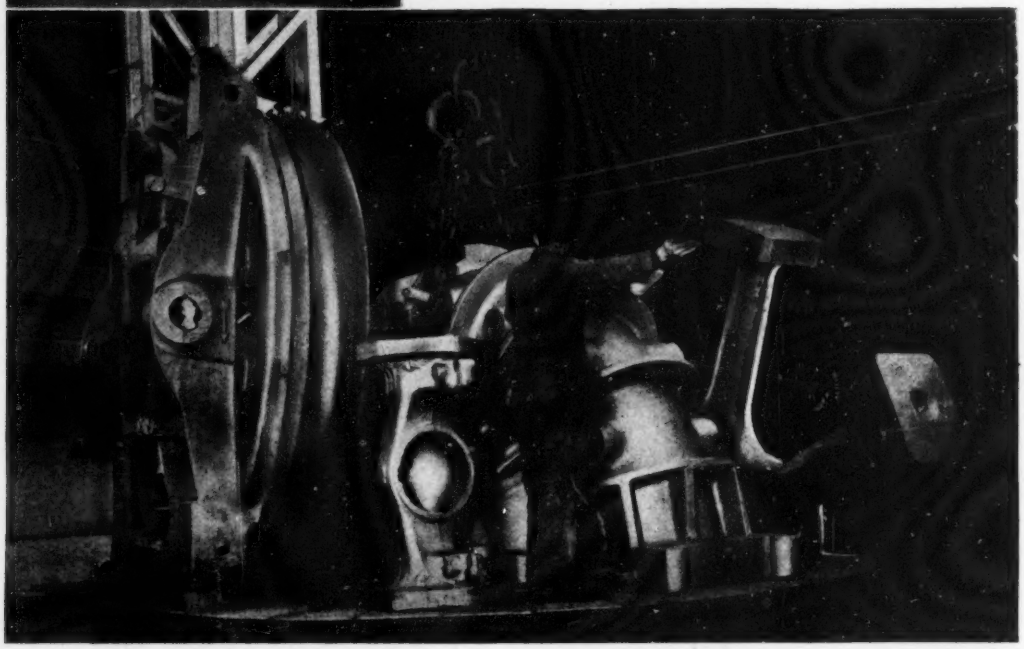
Shot Blast Room Plant

The Tilghman's Wheelabrator Room Plant shown in the accompanying illustrations is 30ft. by 25ft. by 16ft. high, and is installed at Messrs. F. H. Lloyd and Co. Ltd., Wednesbury. This plant, which is fitted with five Wheelabrator units, handles the production from two large bays, the components being loaded on to a bogie equipped with a circular table. Rotating and oscillating motions are provided to the bogie during the cleaning cycle, ensuring maximum blast coverage.



TILGHMAN'S LIMITED BROADHEATH ALTRINCHAM CHESHIRE

LONDON OFFICE: 1 Chester Street, S.W.1. A member of the Staveley Coal and Iron Co. Ltd. Group

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- **MOTOR**
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- **MANUAL OR AUTOMATIC CYCLE**
- **REAR SLIDES**
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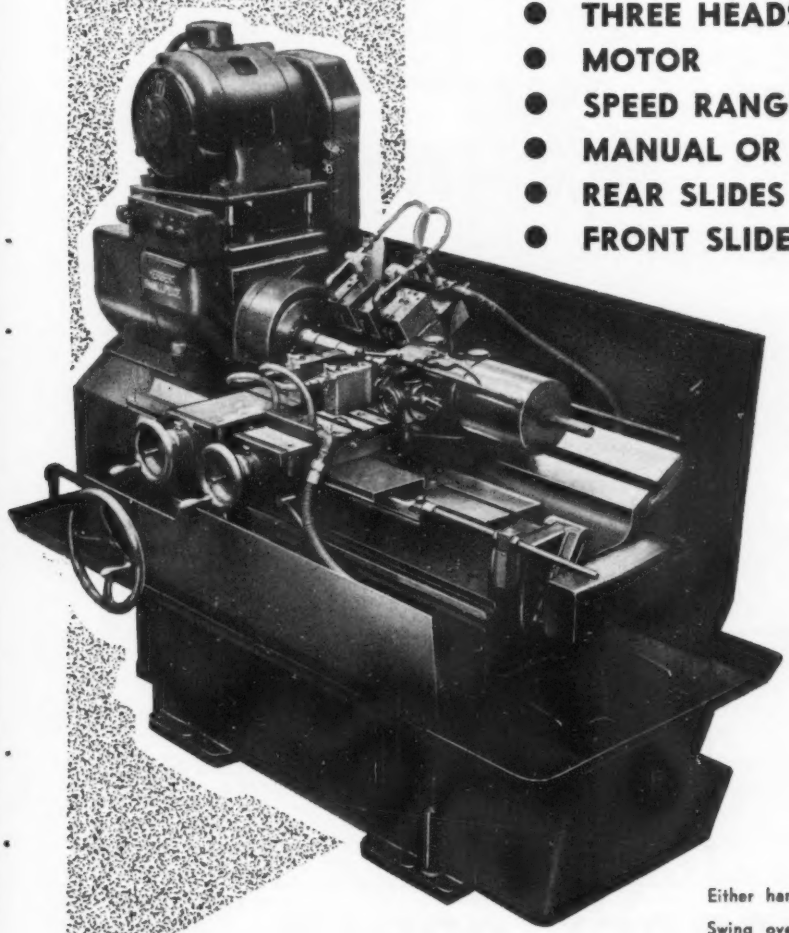

A unit-constructed machine which enables tooling for wide variety of long and short components to be arranged quickly in any combination by means of slides and attachments.

Either hand or automatic cycle control
Swing over bed ... ... 12"
Admits between centres ... ... 29"

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BARNES *Hydraulic*

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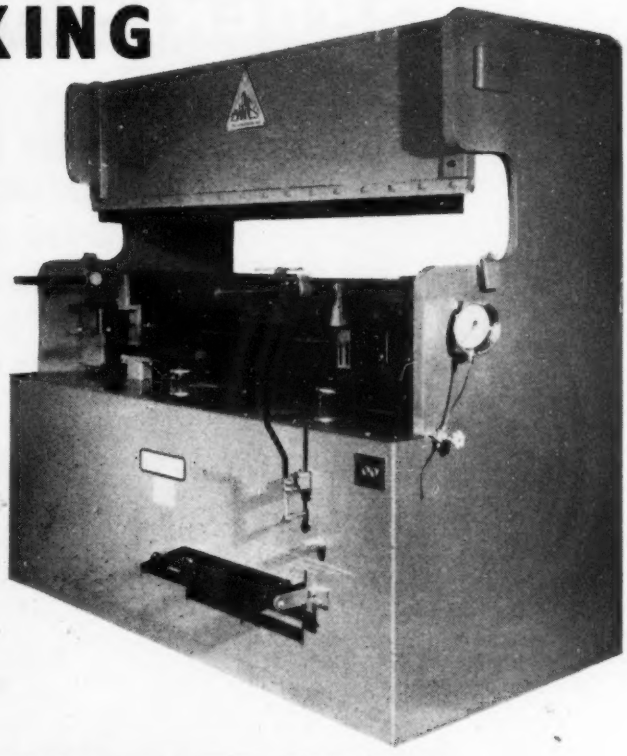

★ UNIVERSAL IN APPLICATION—Any thickness of material within the rated capacity can be worked without resetting.

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★ OPEN THROAT DESIGN.

★ STANDARD EQUIPMENT — includes 7 groove die, 90° punch, adjustable gauges.

RATED CAPACITY IN MILD STEEL	PRESSURE IN TONS	LENGTH OF STROKE
6' 0" x $\frac{1}{8}$"	56	0 — 8"
6' 0" x $\frac{1}{4}$"	70	0 — 12"
6' 0" x $\frac{3}{8}$"	105	0 — 12"
6' 0" x $\frac{1}{2}$"	140	0 — 12"
8' 0" x $\frac{7}{16}$"	70	0 — 12"
8' 0" x $\frac{1}{4}$"	105	0 — 12"
8' 0" x $\frac{3}{8}$"	140	0 — 12"
8' 0" x $\frac{1}{2}$"	175	0 — 12"

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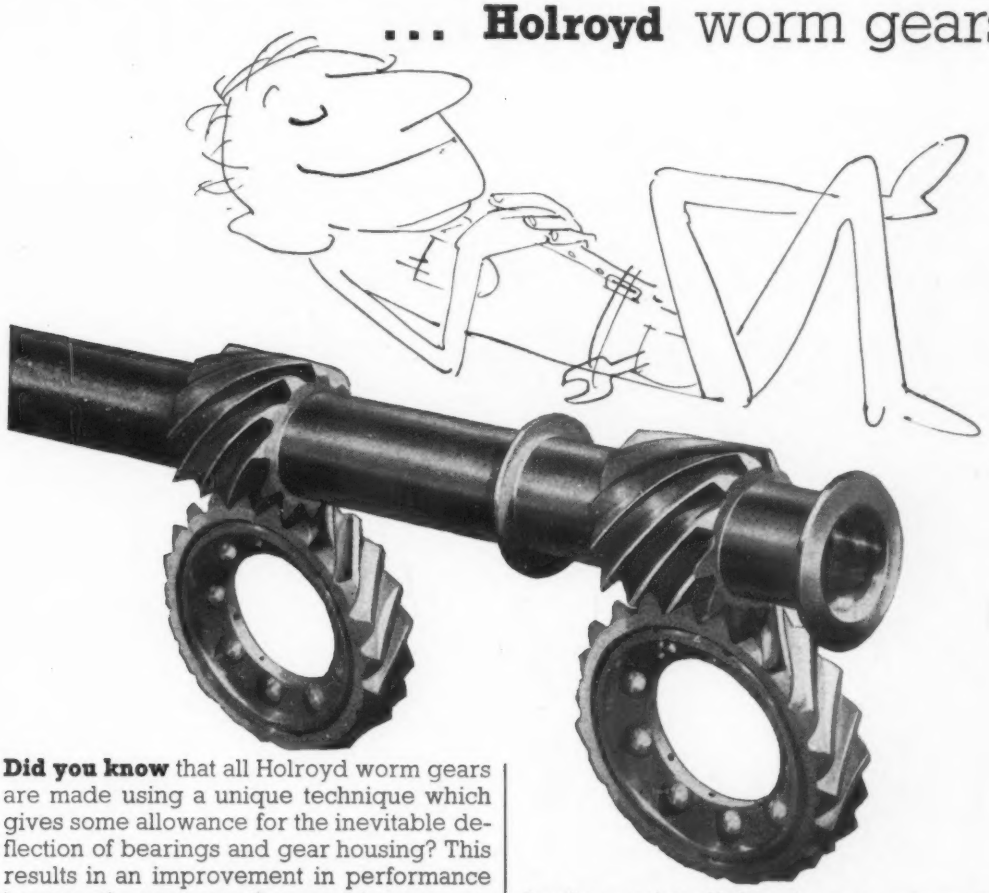

Did you know that all Holroyd worm gears are made using a unique technique which gives some allowance for the inevitable deflection of bearings and gear housing? This results in an improvement in performance because the gears are then working correctly in the **loaded** position. We are able to do this by a technique of manufacture which gives precise control over the tooth marking. In certain cases we go further than this and make the gears so that they have some latitude in assembly without impairing the efficiency. This is particularly valuable where the gears are difficult of access for adjustment during assembly.

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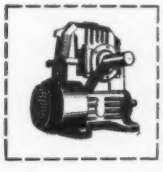
And don't forget that Holroyd worm gears around 1/1 or 2/1 ratio will carry several times the load which can be put through a pair of straight faced spiral gears of the same dimensions, and will work with an efficiency of the order of 97 per cent.



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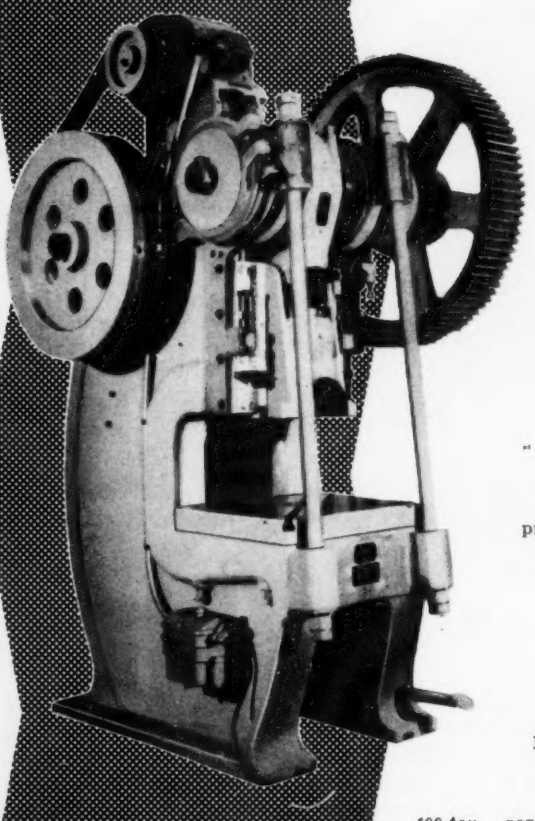

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The Butterley range of sheet metal machinery includes geared and ungeared power presses, guillotine shears, press brakes and general machinery for the hot and cold working of metals.

All castings are made by the "Meehanite" process in our own well-equipped foundries. The Butterley foundries are available for the production of high-grade "Meehanite" castings to customers' requirements. We invite your enquiries for "Meehanite" castings of all grades up to 20 tons.

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100-ton geared open-fronted press with wheel guards removed

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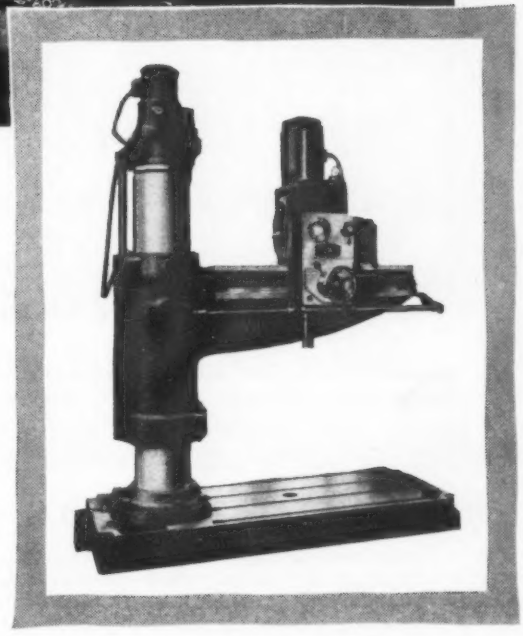

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MOTHERWELL

In September 1937 Messrs. Hurst Nelson & Co. Ltd., bought their first TOWN drilling machine —to-day they have thirty-four. Eight of these are pictured above—all TOWN A.E.4's, installed since 1955. For sturdy, reliable, up-to-date drilling machines there's no better place to go than TOWN'S.

Model A.E.4 (inset) Seven sizes: 3' 6", 4', 4' 6", 5', 6', 7', 8'; 12 speeds, 34-1000 r.p.m.; alternatives; 23-670, 28-825, 51-1465 r.p.m. drills 3" from solid in mild steel and cast iron.

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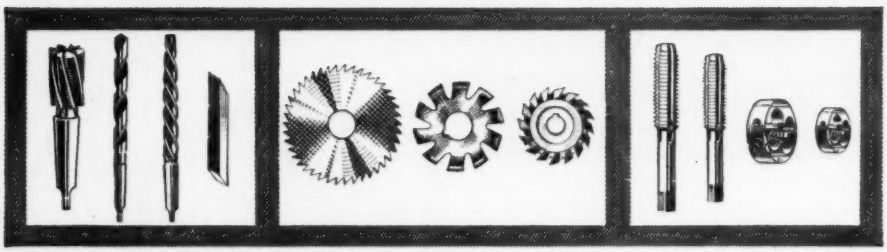

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Production milling time on many different components can be cut considerably with this versatile Model 2VR continuous vertical miller, with first-class finish and without strain on the operator.

Continuous milling cuts the unproductive waste out of floor-to-floor times. No time is lost in traversing or loading and unloading. The 2VR is milling *all the time*.

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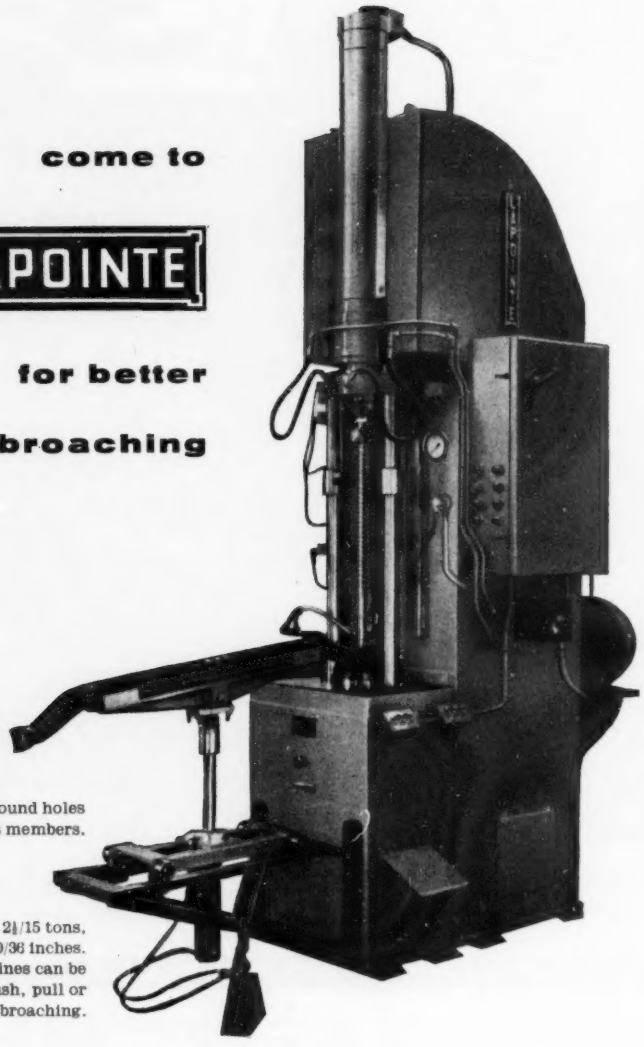

Broaching round holes in cross members.

Capacity: 2½/15 tons, stroke: 24/30/36 inches. These machines can be supplied for push, pull or surface broaching.

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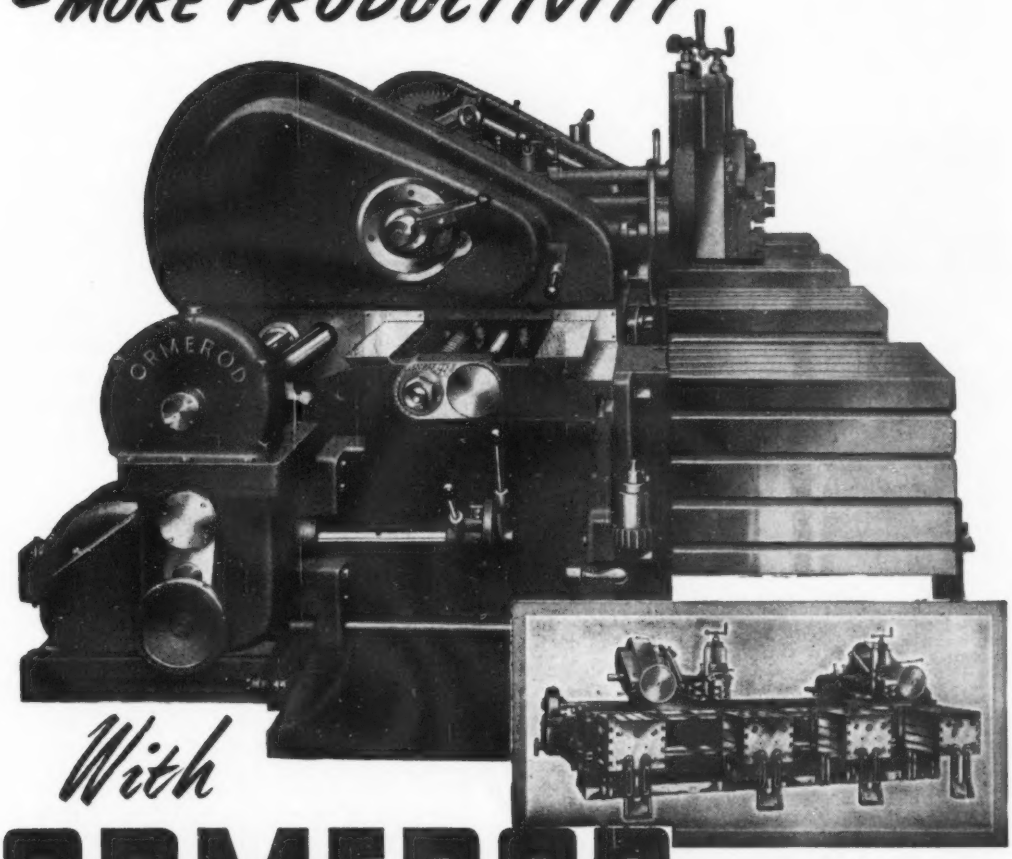

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High Speed SHAPING MACHINES

These versatile machines take in their stride work of the most unusual size and shape. Machines with two heads are capable of simultaneous and independent machining of a single piece. Each nine-speed ram has a swivelling toolhead, self-acting vertical feed and automatic tool lifter. Available in four sizes with one head and two tables and two heads and two tables; the lengths of stroke are 16in., 20in., 26in. and 32in., with lengths of bed to suit requirements.

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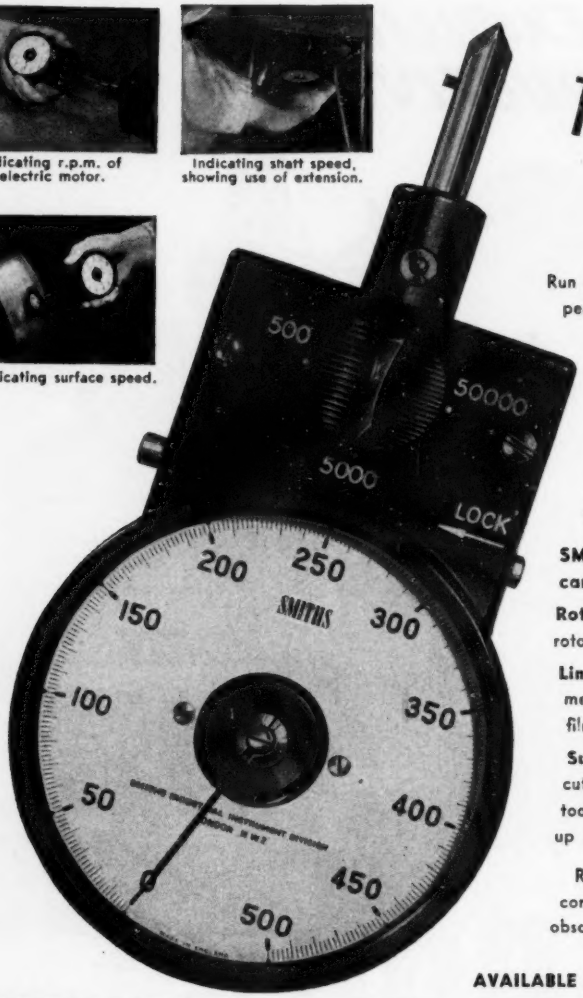

The Right REVS

Run your machinery at the optimum speed for peak efficiency. Any deviation from this speed almost certainly means that it—and you!—are running at a loss.

Cut this loss by making spot checks of r.p.m. with a SMITHS Hand Tachometer. Such a check can be made in an instant, even in unfavourable conditions. What's more, the reading is accurate to within ½%.

SMITHS HAND TACHOMETERS can be used for checking:—

Rotational speeds of shafts, spindles, gears, rotors and rolls.

Linear speeds in ft/min or metres/min of metal strips, textiles, paper, wire, plastic, film and conveyed material.

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Readings can be taken in bad lighting conditions or where the dial is visually obscured.

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Model A.T.H. 4 (0-50,000 r.p.m.) Illustrated
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PRICE (complete with strong case and full range of accessories) **£14.14.0**
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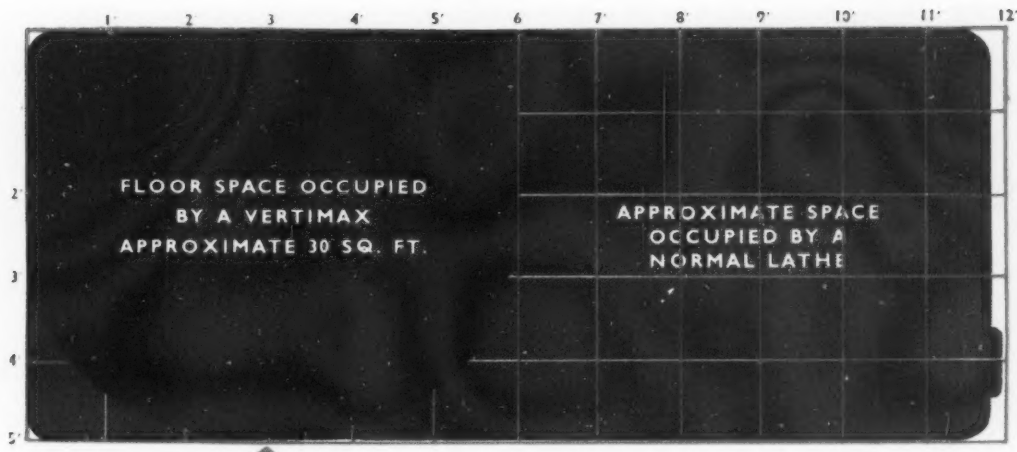

FOR PRODUCTION PER SQ. FT.

The VERTIMAX Vertical Spindle Production Lathe takes little floor space for the range and capacity of work of which it is capable. In fact it takes literally half the space of a comparable horizontal lathe. Also, its exterior is smooth and free from projections.

The VERTIMAX is extremely simple to set up and load. Its features include an air operated chuck and spindle brake, two independent and adjustable tool slides which can be swung through any angle, infinitely variable hydraulic feed, automatic operation and grouped controls.

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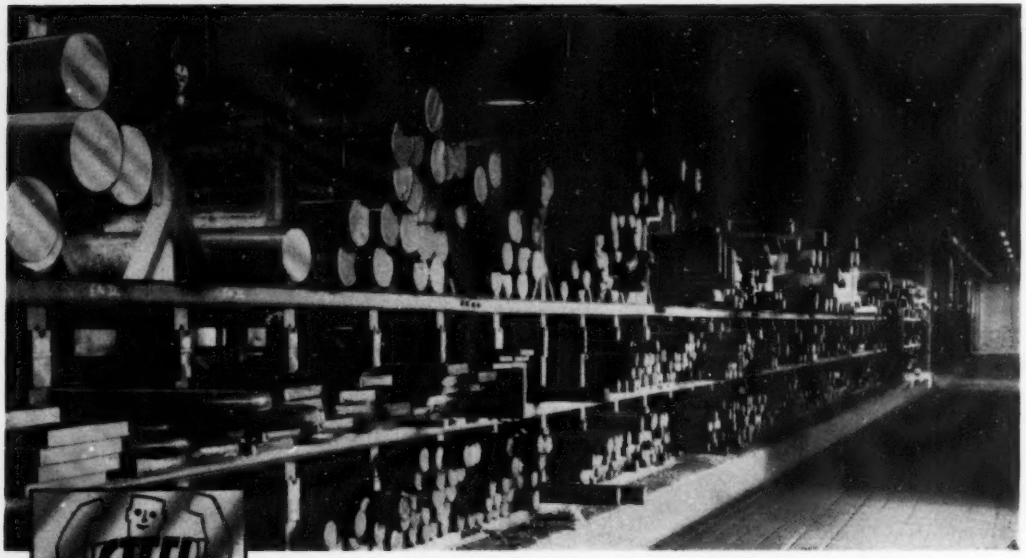

MR. STEEL'S NEW WAREHOUSE FOR HOT ROLLED CARBON & ALLOY STEEL BARS

Macready's Metal Company Ltd. has this additional special warehouse at King's Cross devoted to the supply of Carbon and Alloy Steels.
Very large stocks are held and the warehouse is completely equipped with the modern facilities required to maintain the quick delivery service for which Macready's are famous. Production delays are eliminated when you use Macready's.

5000 TONS OF BRIGHT STEEL are always available at our main warehouse at Usaspead Corner for immediate delivery. Avoid delays by using the Macready service.

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METAL COMPANY LIMITED
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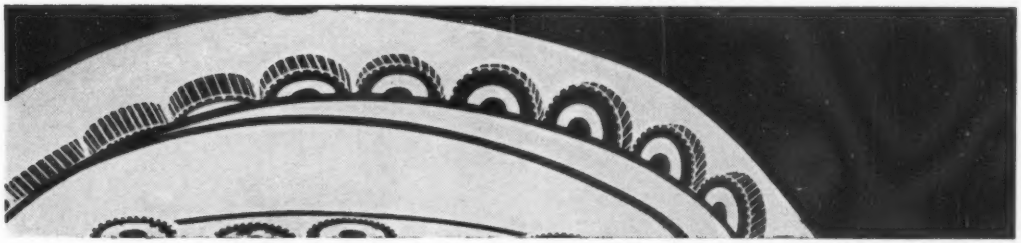
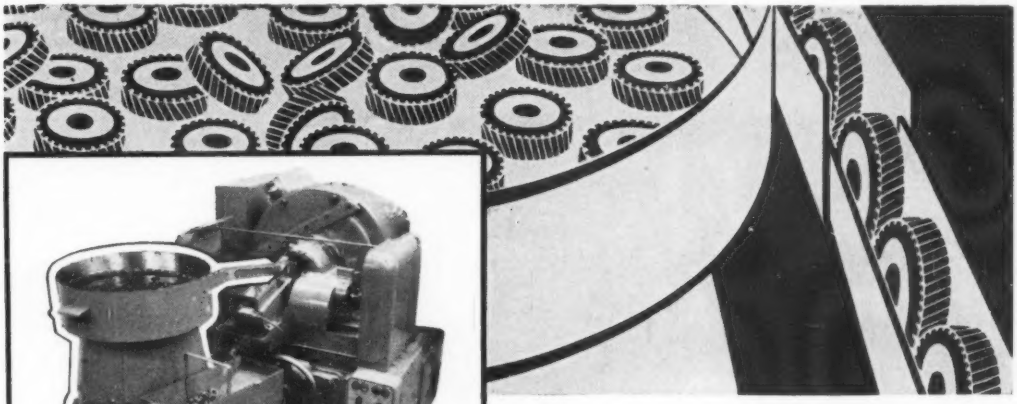
Controlled feeding of components



RIGHT RATE · RIGHT WAY ROUND · RIGHT WAY UP · ONE AT A TIME



The David Brown No. 7 'Hydrax' gear hobbing machine with Syntron Vibratory Bowl Feeder.

The controlled rate feeding of small components is one of many tasks performed by the Syntron Vibratory Bowl Feeder. In the automatic machine for small gear hobbing shown on the left it delivers the gear wheels correctly positioned and in single line for precision machining. Wherever small parts and products must be fed from one process to another, Syntron Vibrators can be made to order, to keep things moving to order.

Write for full details of SYNTRON VIBRATORS for your process

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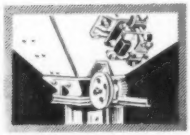
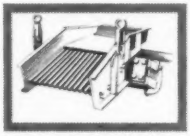
NINETEEN WOBURN PLACE, LONDON, W.C.1. TELEPHONE NO: TERMINUS 2622

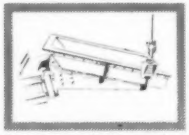


Syntron Electric Vibrators keep bins and hoppers clear with adjustable electro-magnetic vibrations.

Syntron Vibratory Feeders ensure smooth vibratory trough feeding even for the finest powders.



Syntron Grizzly Discharge Feeders give high capacity feeding, and screen and separate fines from abrasives.



Syntron Heavy Tonnage Feeders are robust units capable of handling up to 500 tons of gravel per hour.

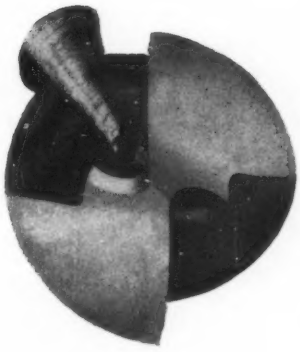
Syntron Packers provide a fast and efficient means of compacting and settling products in containers.

TGA 558

50% increase in inches

FIRTH BROWN TOOLS LTD.

SPEEDICUT WORKS · SHEFFIELD



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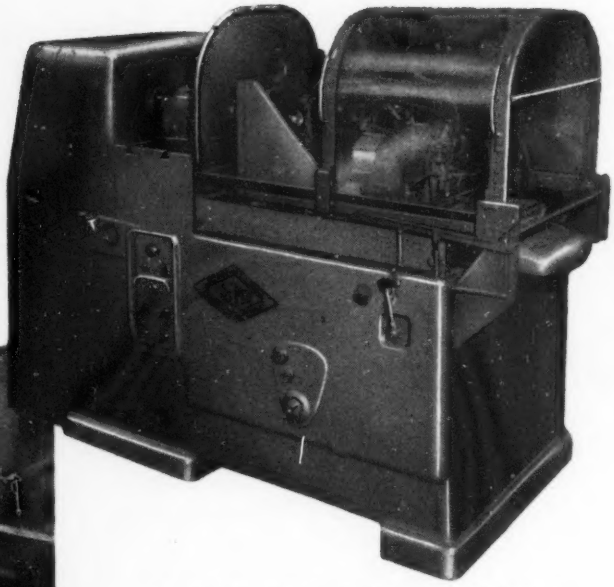
Under closely controlled tests at one of the largest Constructional Engineering Works in the country, *SPEEDICUT "CHIPBREAKER" DRILLS* 15/16" diameter, dry drilling mild steel plates, each drilled an average of 3108 holes between regrinds. This is reported as 50% more than any other type of drill tested at these Works.

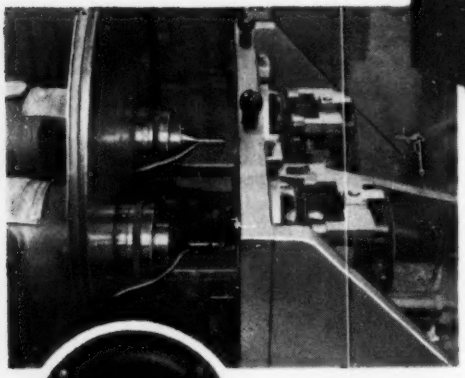
Take advantage of the latest techniques in toolmaking—
SPECIFY SPEEDICUT.

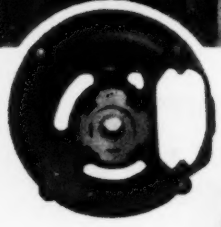
with the **SPEEDICUT**
chipbreaker
drill

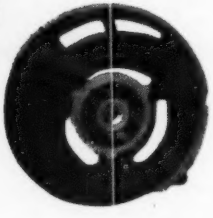
11 IN OPERATION AT B.T.H.

On this two spindle PRECIMAX fine borer, end shields for fractional horse power motors are finish bored in a time cycle of only 30 seconds. The machine cycle is fully automatic and limits are maintained within 0.00015in.









B.T.H. Ltd., who have eleven PRECIMAX fine boring machines in operation, are only one of a growing number of manufacturers who are finding that the precision, versatility and production efficiency of their machine means an improved product and lower costs all round. Ask us for complete details. Write today.

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FINE BORING MACHINES

for precise and maximum output

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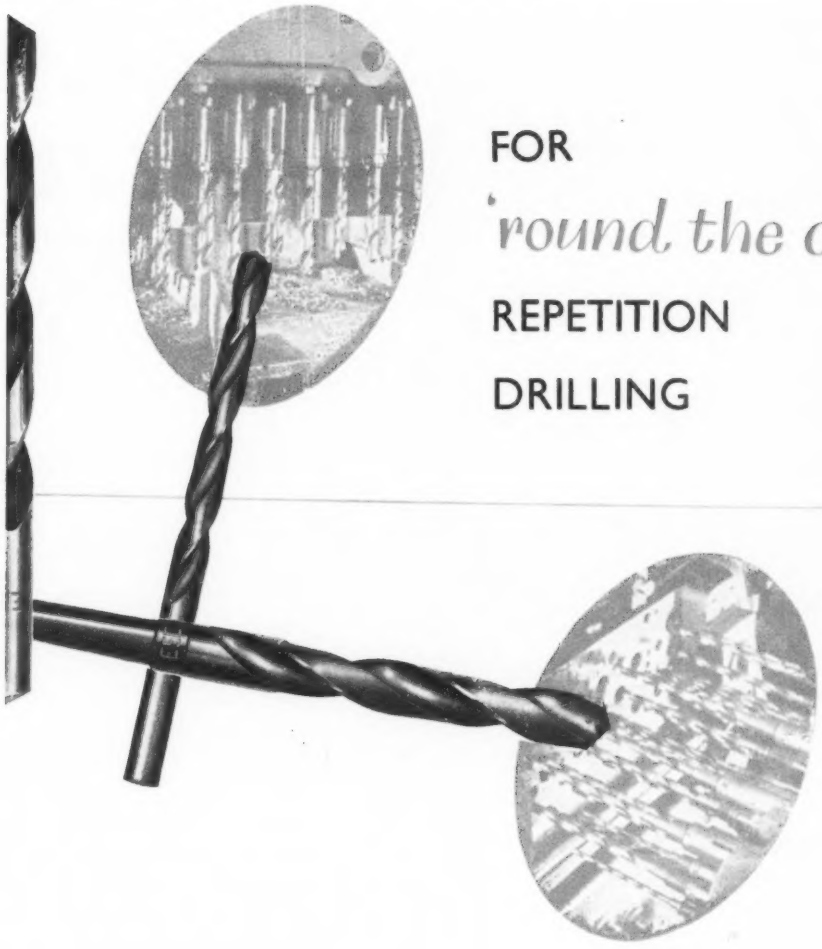

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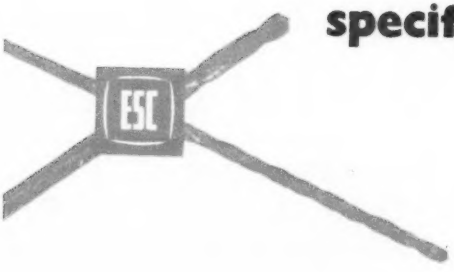
REPETITION

DRILLING



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Repetition and Multi-Drilling operations can be kept to a tight schedule by the use of "Easicut" drills which give maximum performance and embody the results of extensive research into drilling problems.

ENGLISH STEEL TOOL CORPORATION LTD

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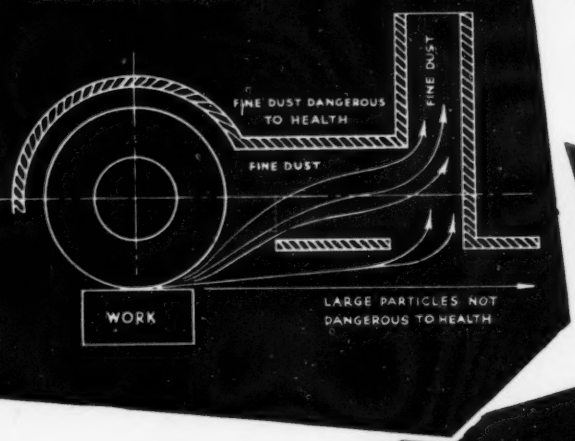
Now fitted with latest officially approved method of dust control



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Embodying the British Steel Castings Research Association system of Dust Control and in compliance with the latest Government Iron and Steel Foundry Regulations.

- For all large castings and forgings too heavy to handle on a floor grinder, also for billet grinding.
- A heavy duty machine, with the most efficient known dust extraction system, yet exceptionally easy to handle. Free to swivel or can be easily locked rigid.
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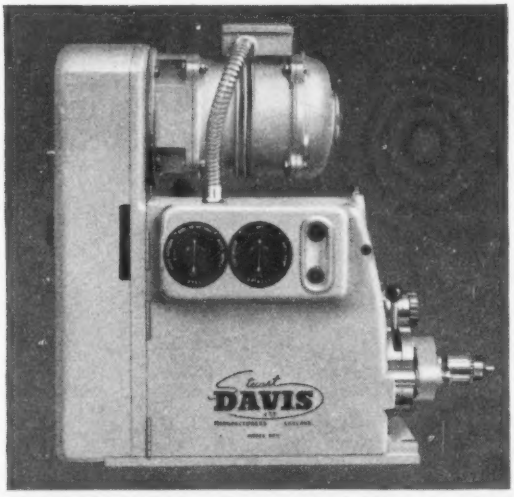

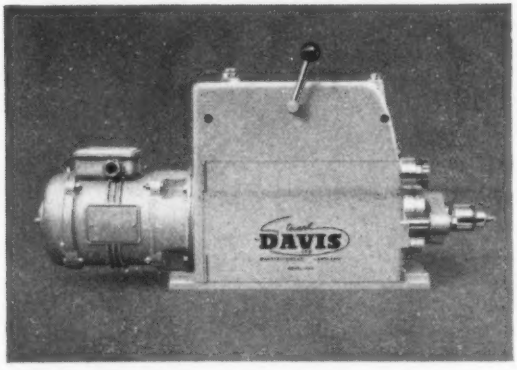

probably only one
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standard drilling units.

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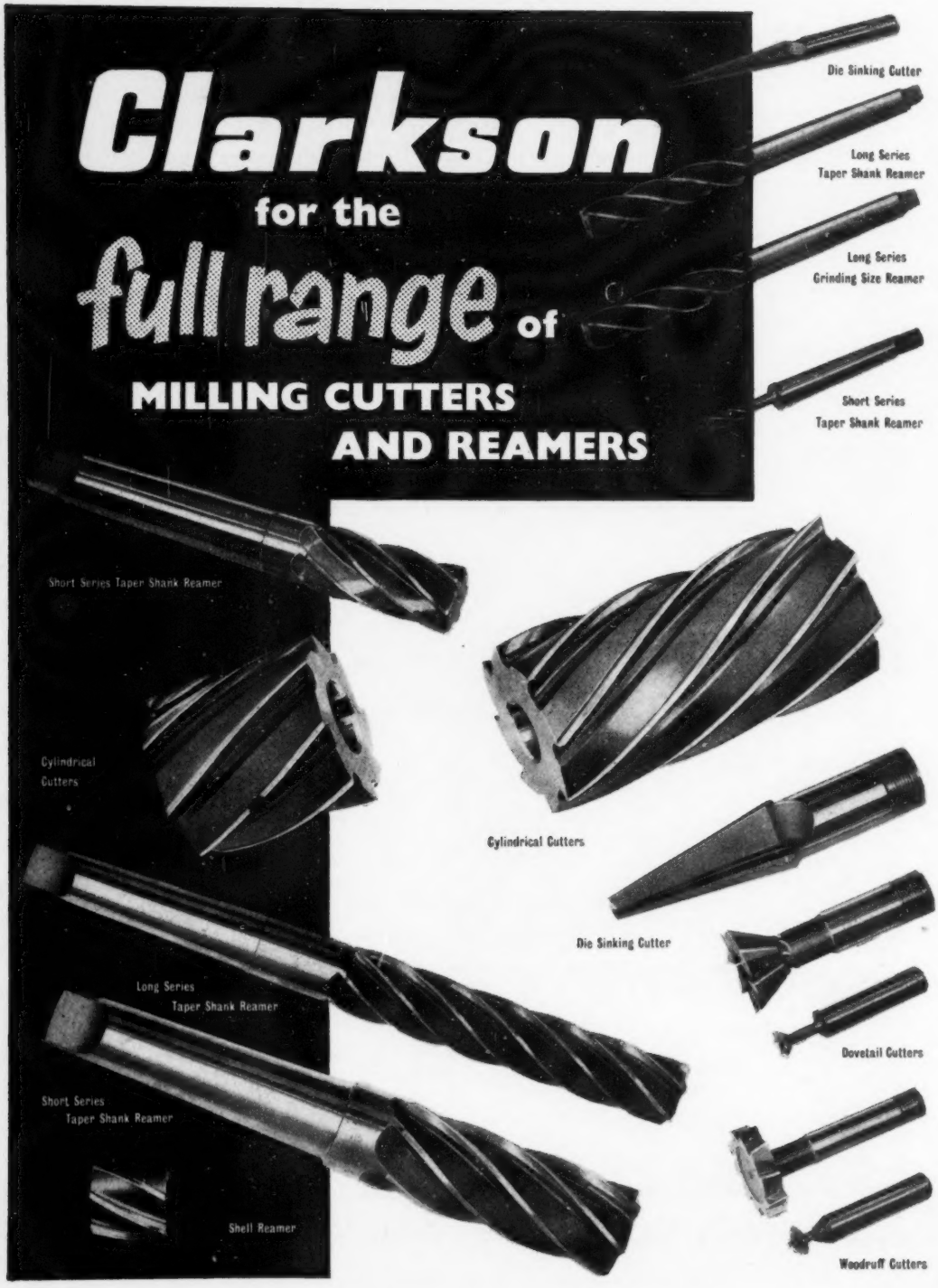

Angle Cutter

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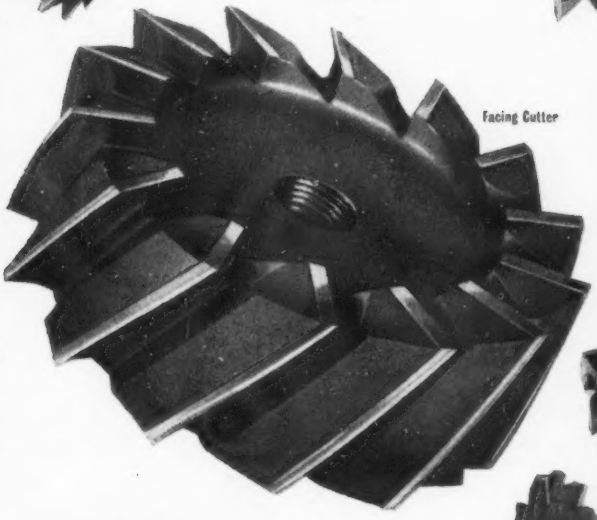
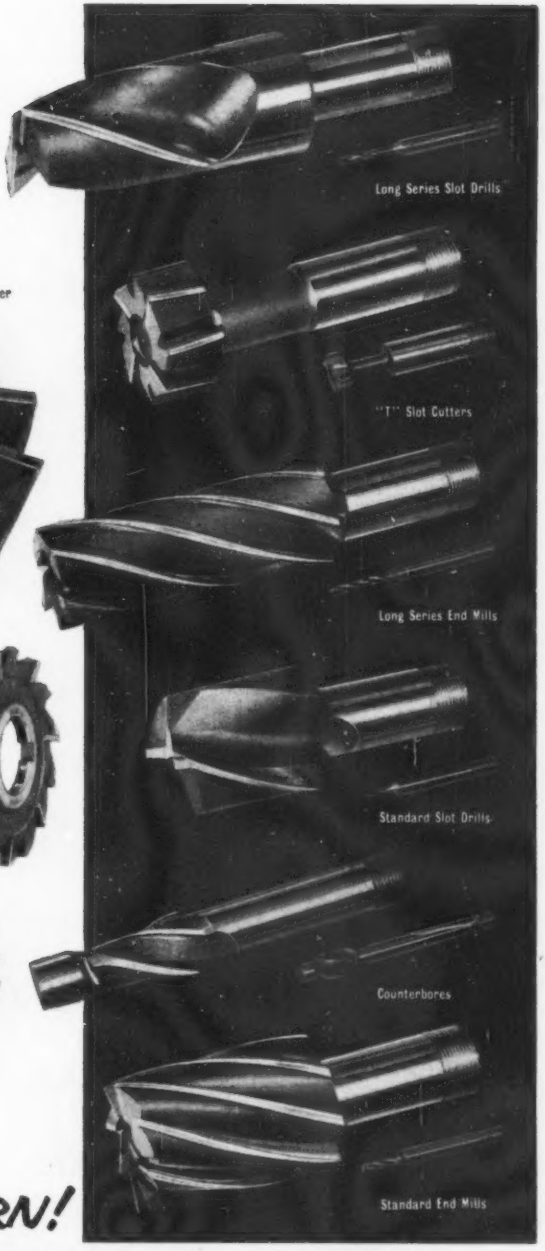


Facing Cutter

Spiral Side & Face Cutter

Spiral Side & Face Cutter



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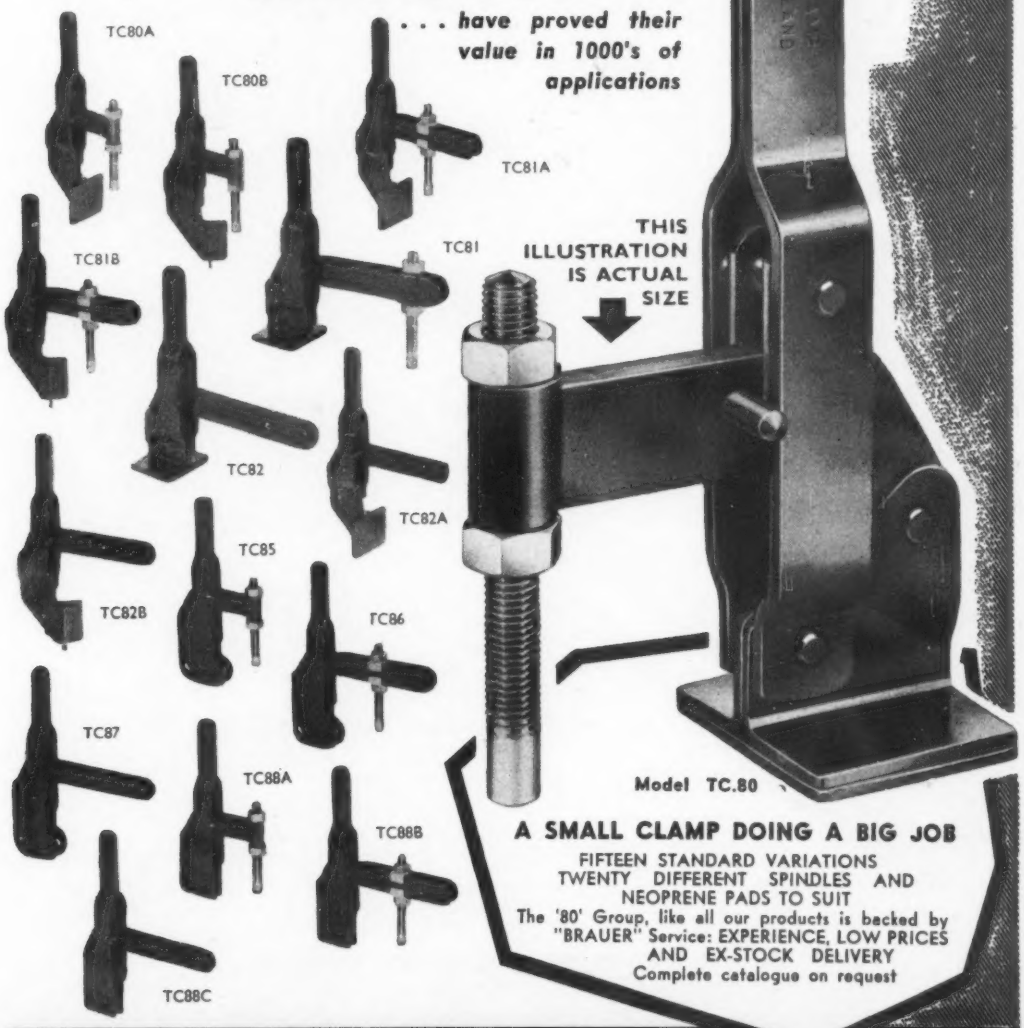

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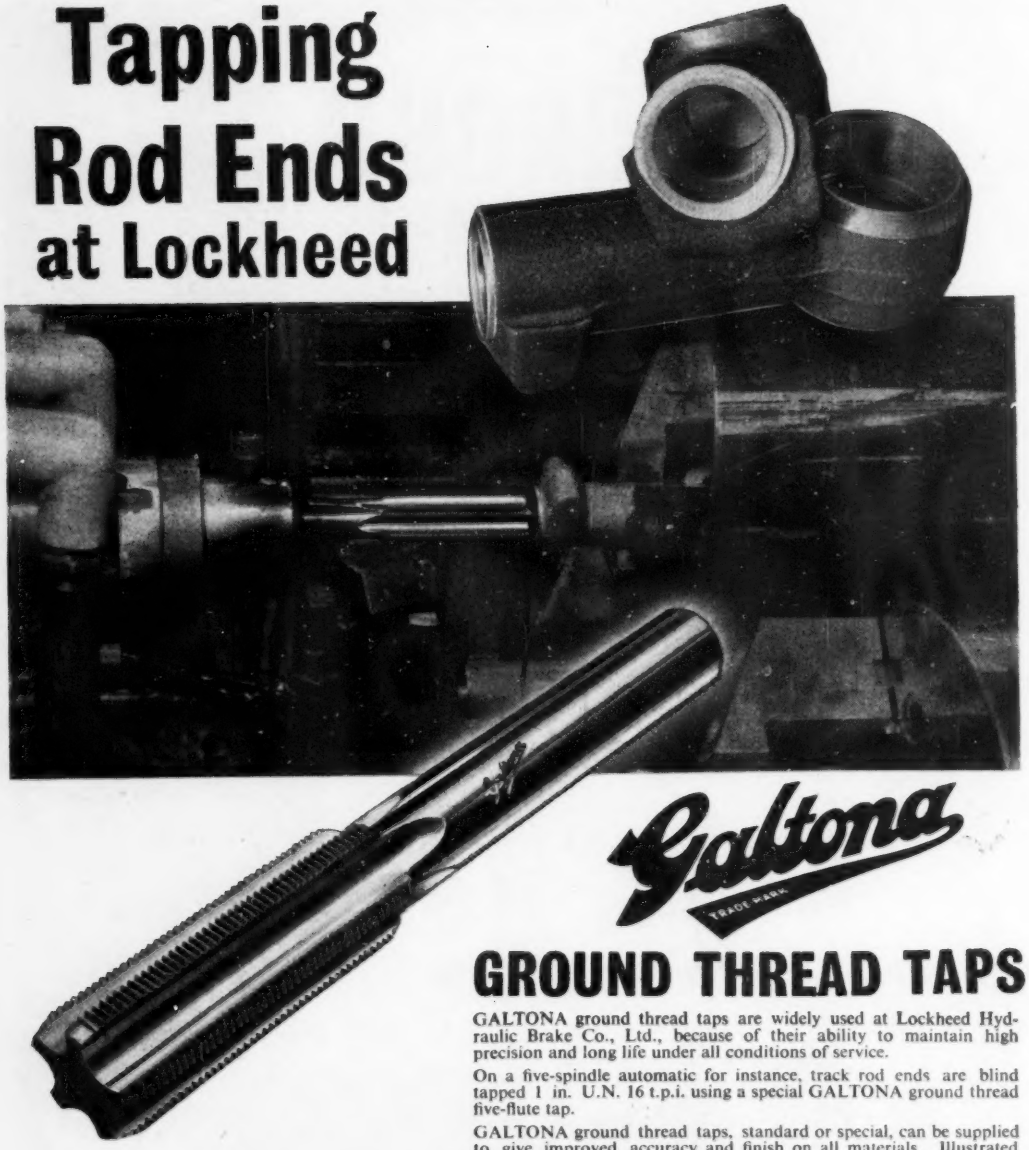

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GROUND THREAD TAPS

GALTONA ground thread taps are widely used at Lockheed Hydraulic Brake Co., Ltd., because of their ability to maintain high precision and long life under all conditions of service.

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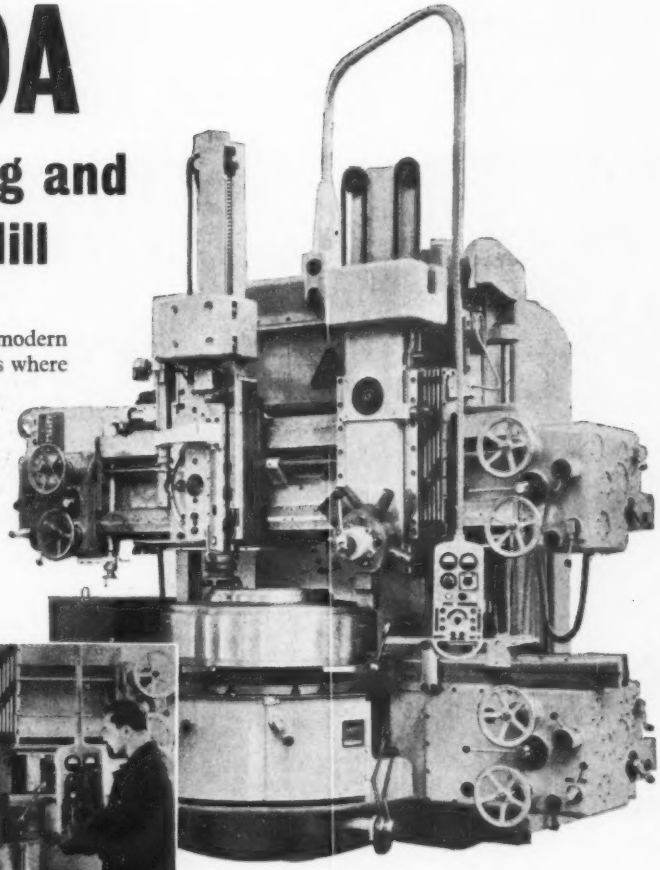

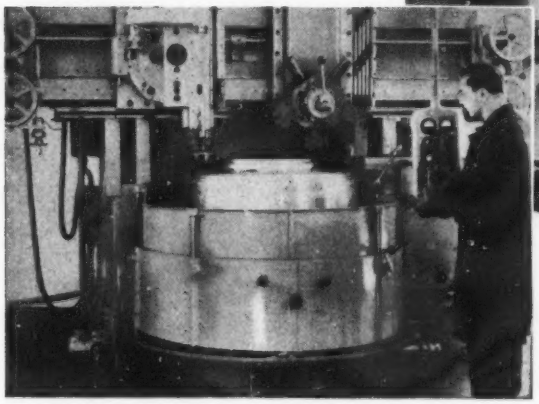

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Maximum swing without side head	53 in.
Maximum distance between table and rail head toolholder	39 in.
Table diameter	46½ in.
Infinitely variable speed from	3.55-150 r.p.m.
Variable speed motor output	27 kW.
Weight of machine	15 ton 12 cwt. approx.

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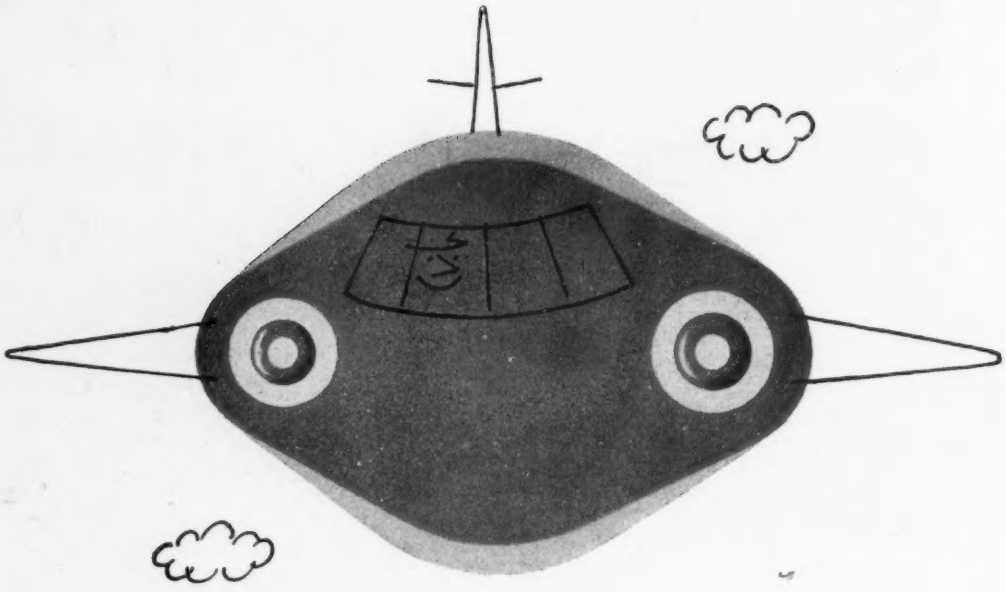

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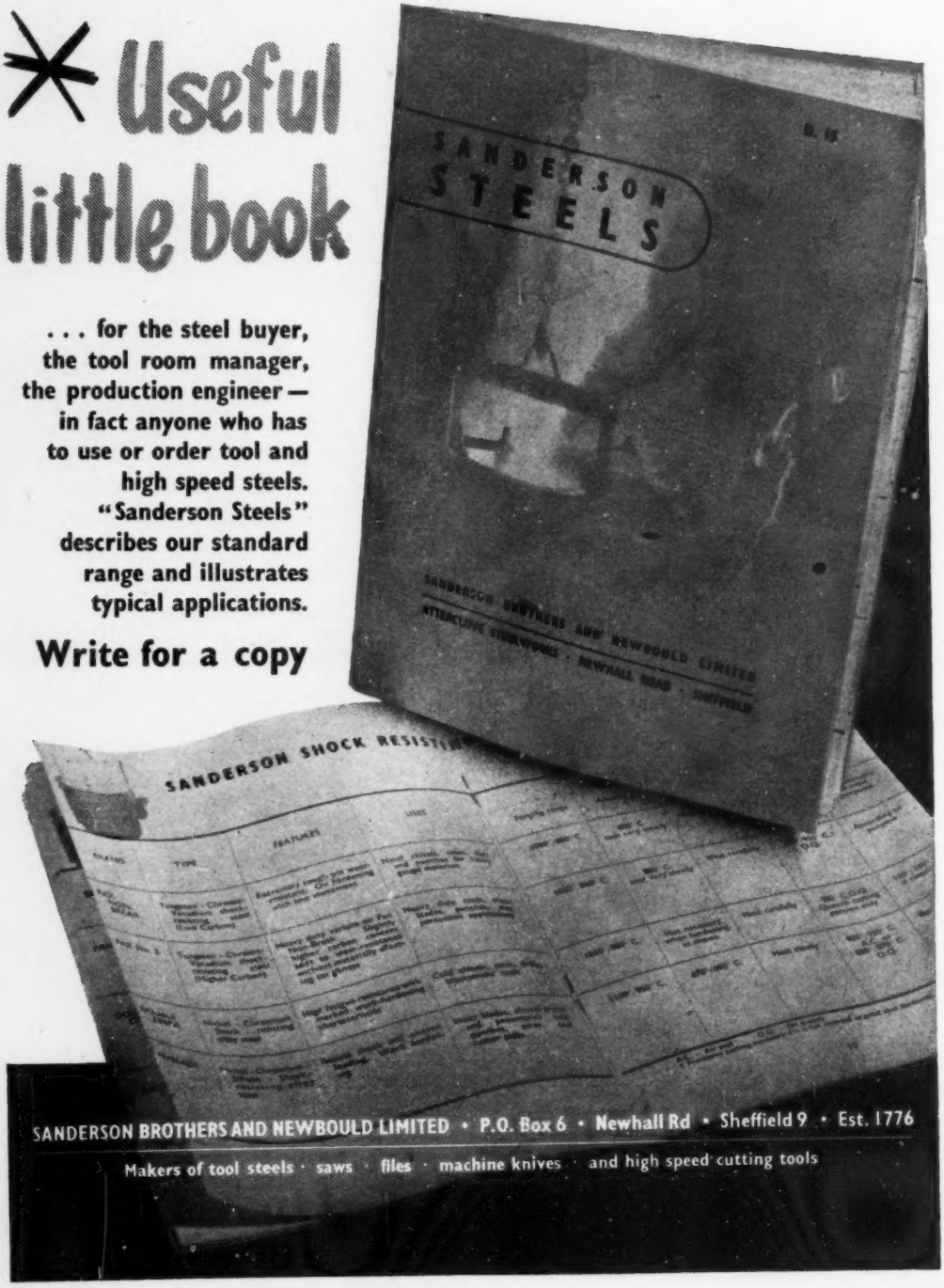
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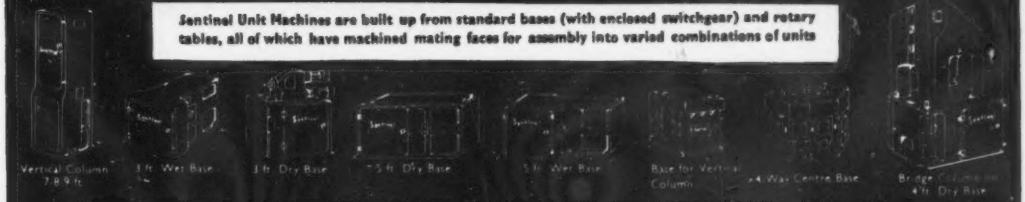
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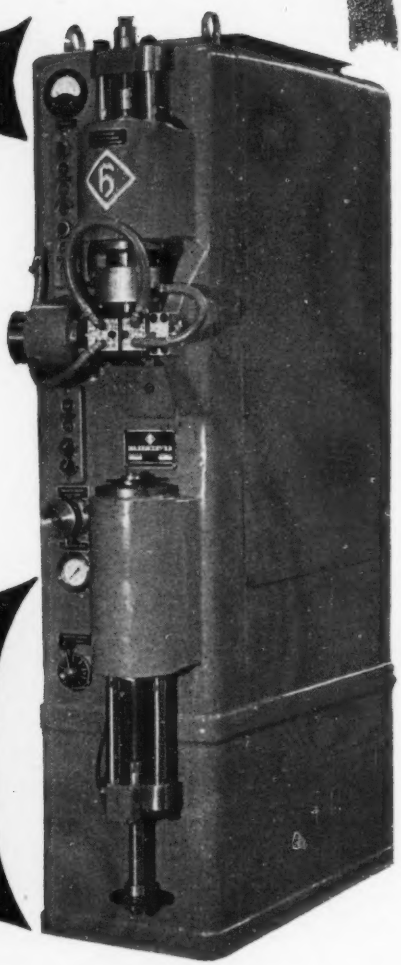

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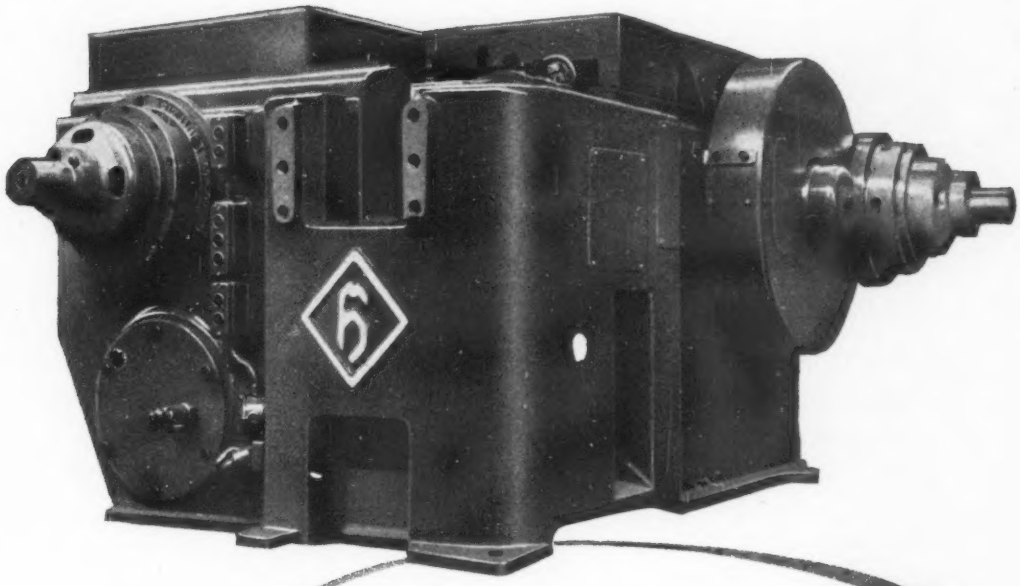

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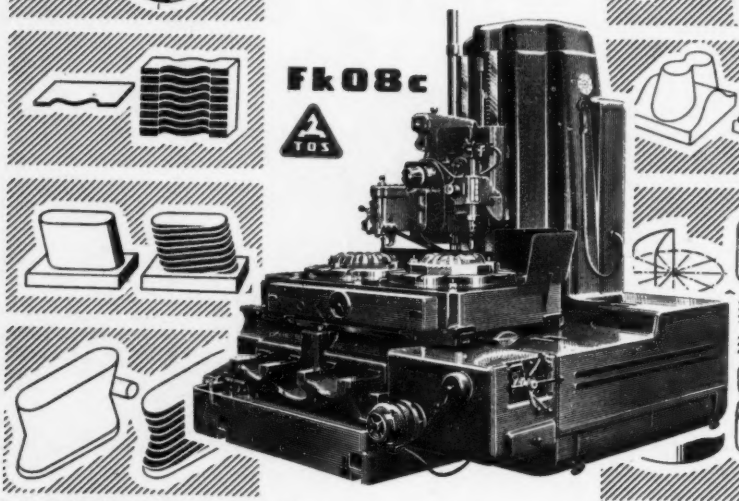

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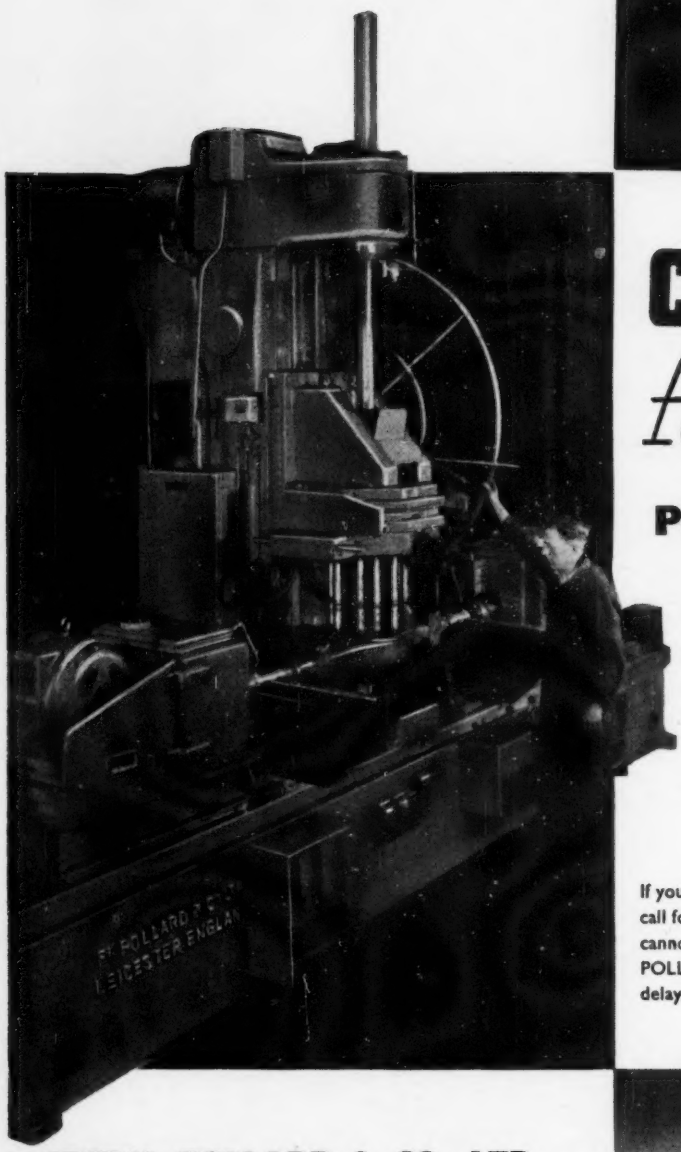

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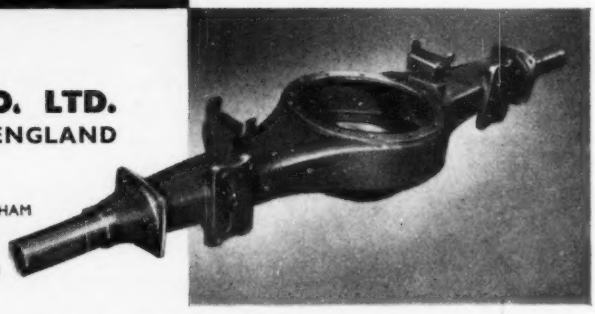

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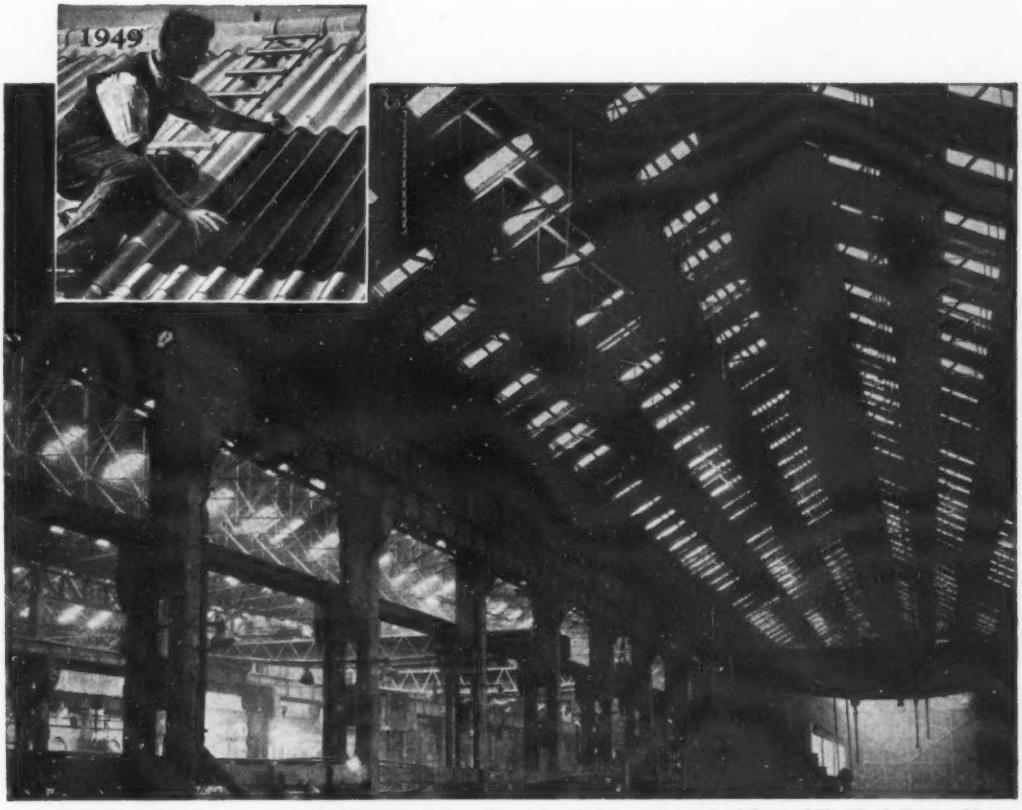

This installation of Corrugated 'Perspex' is in the factory of The North Eastern Marine Engineering Company Ltd., Wallsend, Northumberland. It has been installed over 8 years.

Corrugated 'Perspex' as efficient as ever after 8 years continuous use in engineering factory

FOR OVER 8 YEARS Corrugated 'Perspex' has been in continuous use in a large engineering factory. Through all that time it has given good efficient service. Indeed, the North Eastern Marine Engineering Company Ltd. say in their letter that it has been so successful they have added considerable new installations of Corrugated 'Perspex'.

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CORRUGATED 'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

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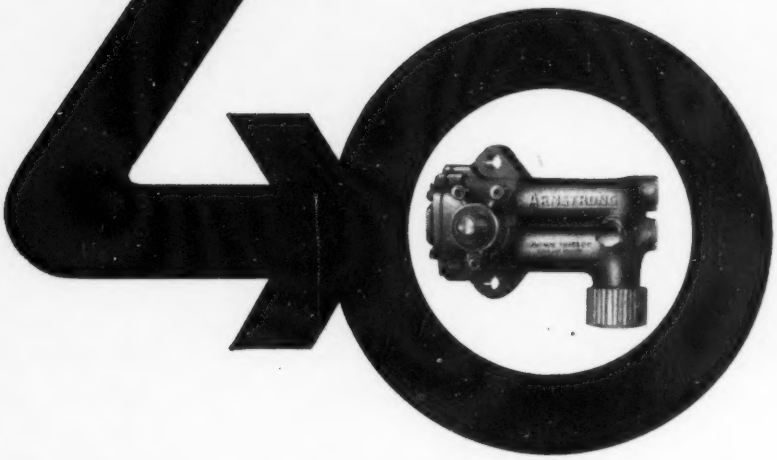

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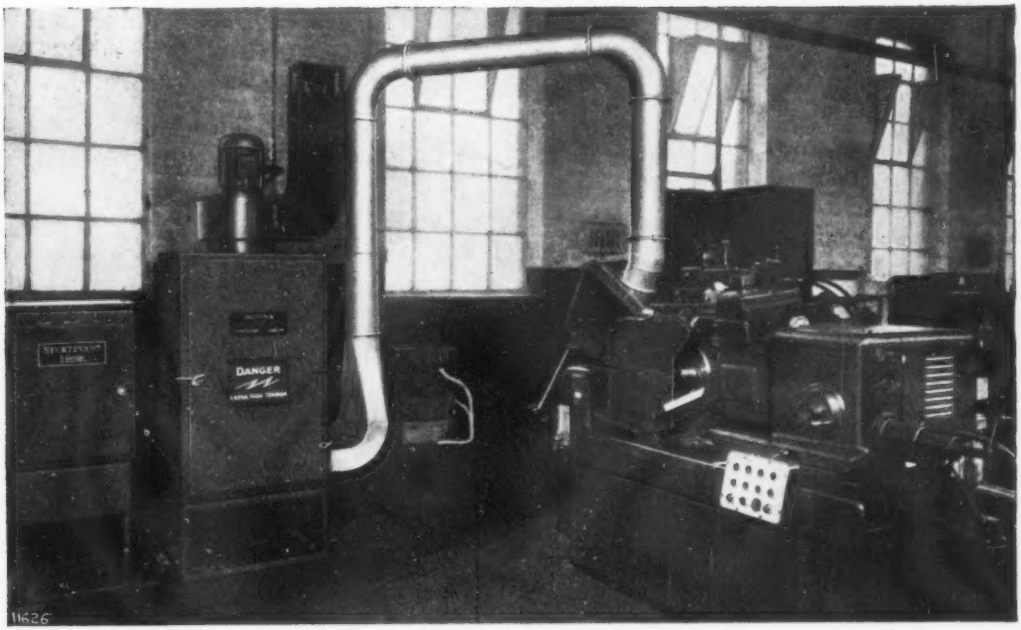

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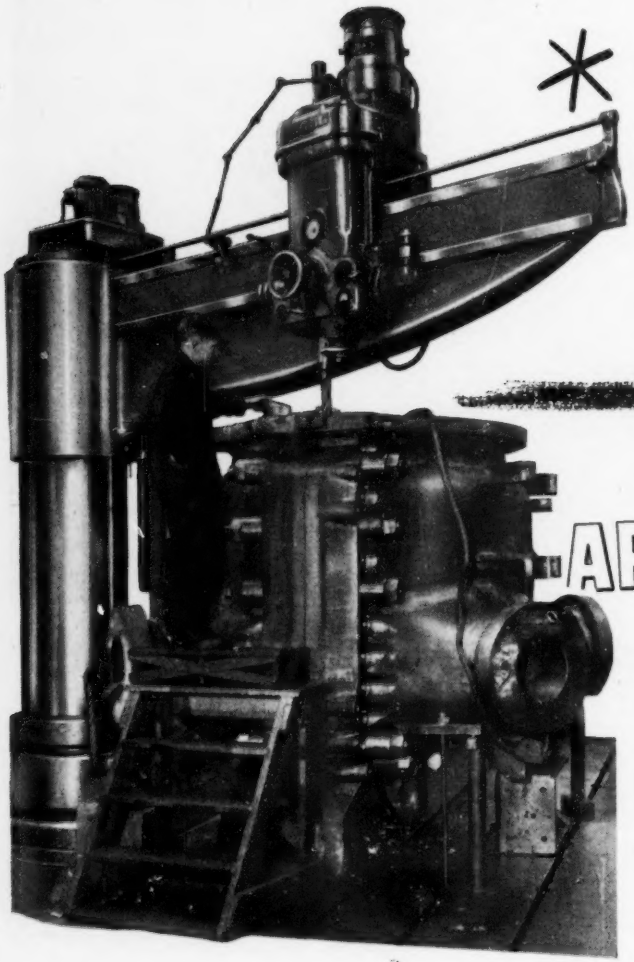

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HYDRAULIC "PRE-SELECT"

At B-T-H Ltd Rugby

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These machines give 22 spindle speeds and 18 rates of feed, all pre-selected at any time, with the spindle stationary or running.

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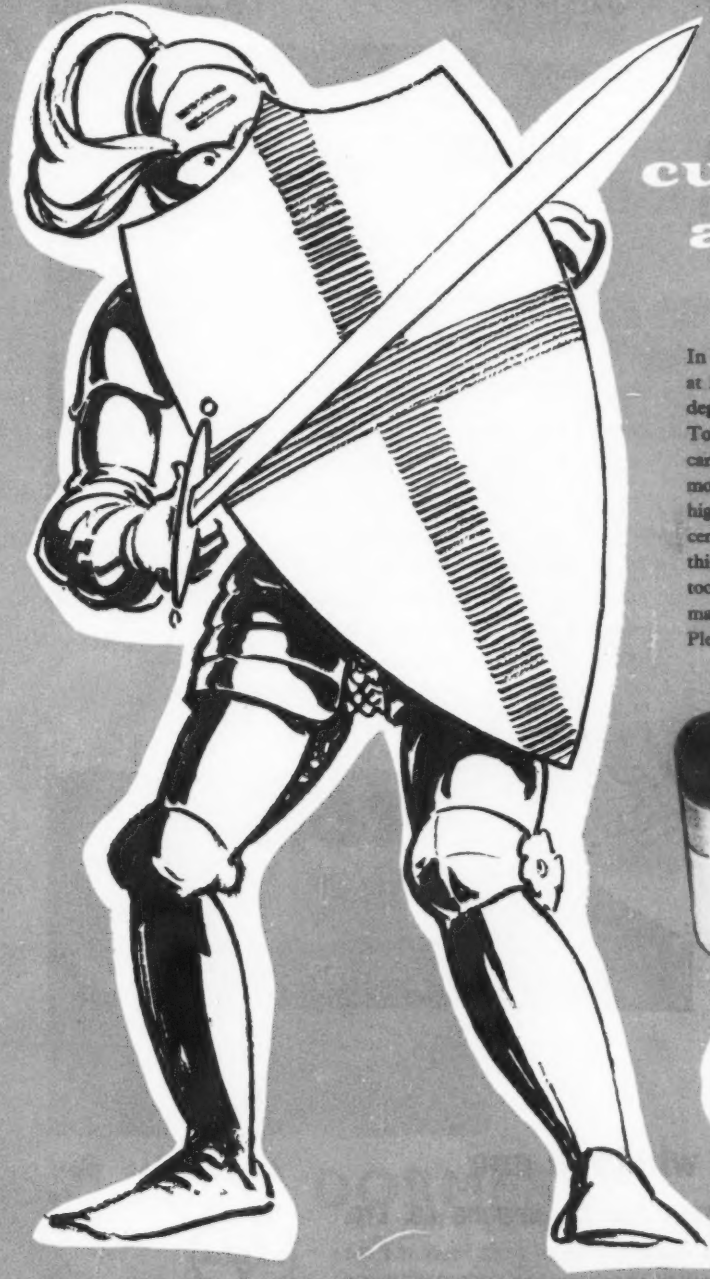

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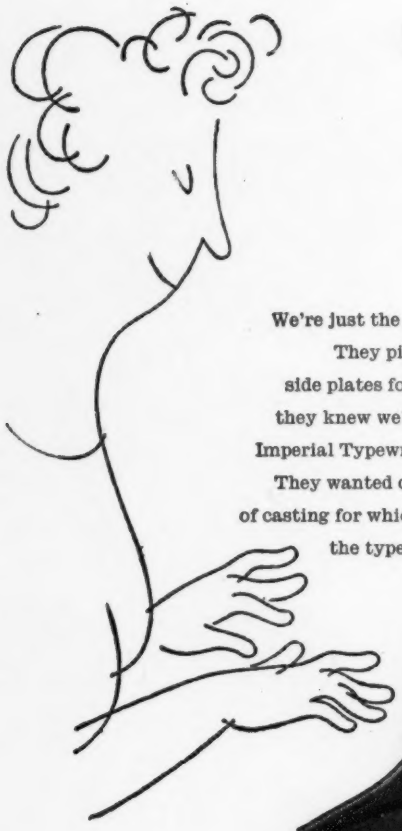

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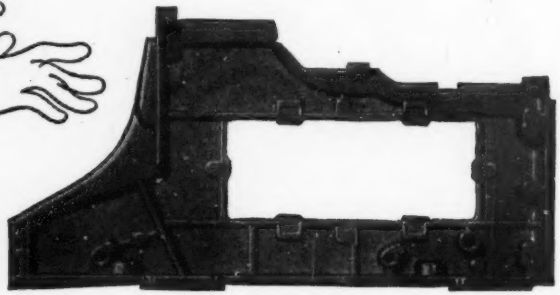

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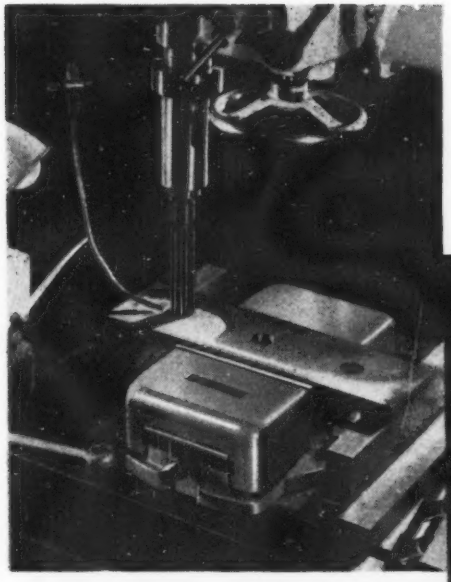

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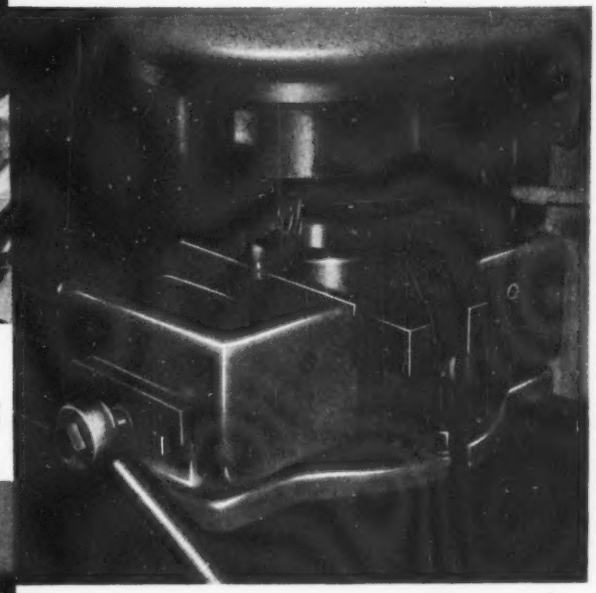
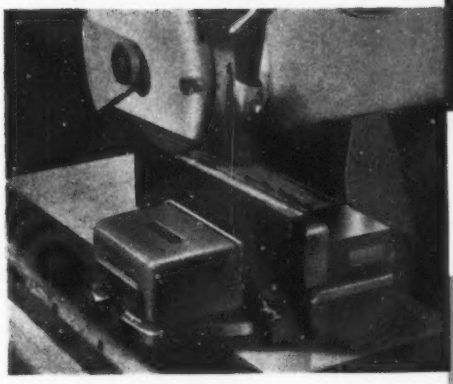


. . . . . .Milling, Slotting



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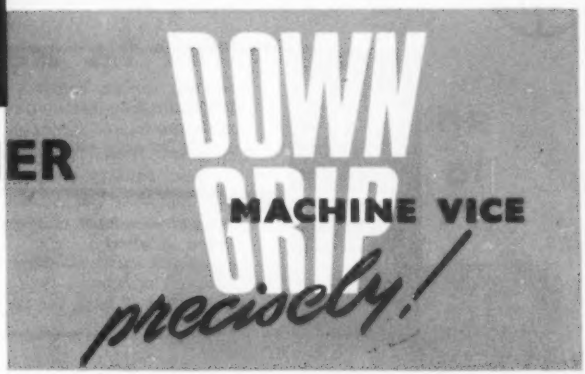

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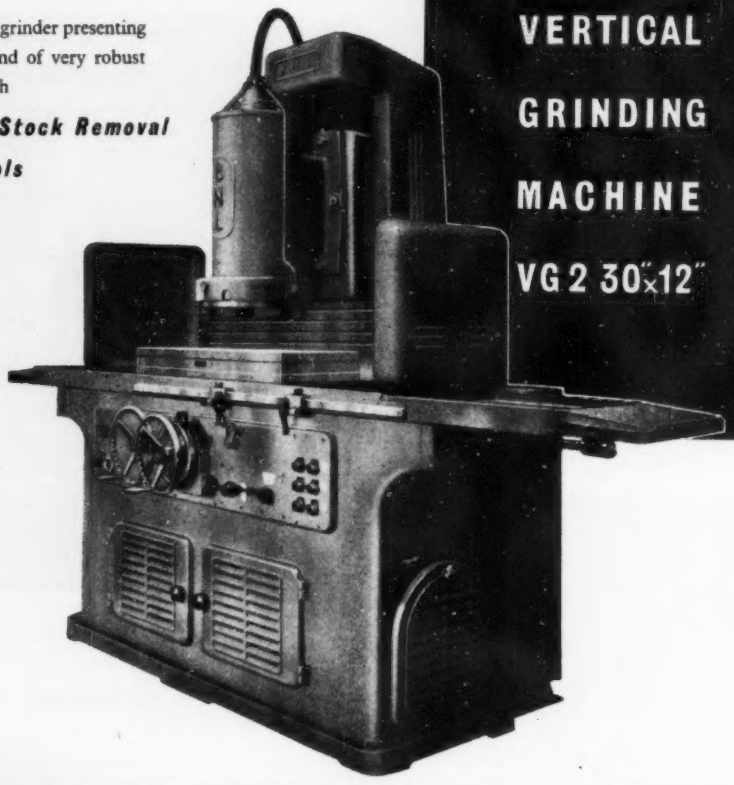

TABLE	working surface, length x width	30" x 12"
	longitudinal traverse	45"
	table speed	0-48 ft/min
	admits between table and wheel	12"
HEAD	vertical movement of wheelhead	13"
	speed of wheel	1420 r.p.m
	peripheral speed of wheel	4750 ft/min
	diameter of wheel	12"
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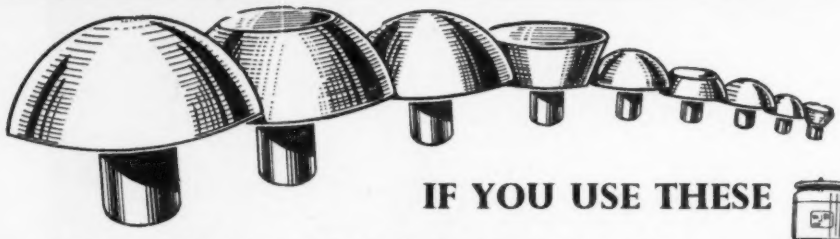

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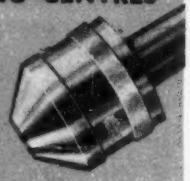

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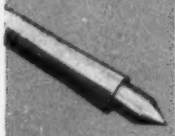

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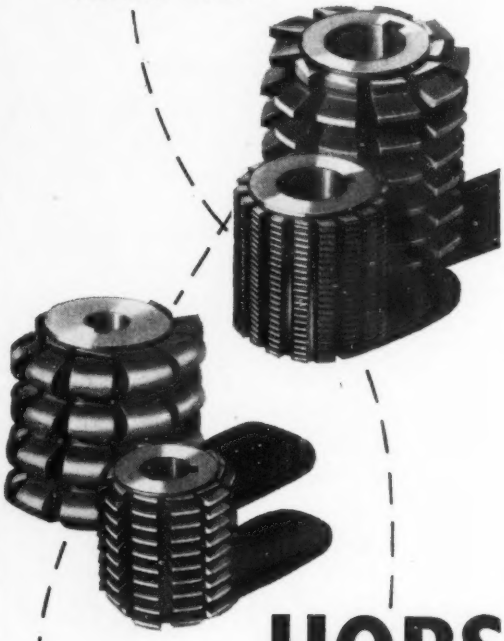

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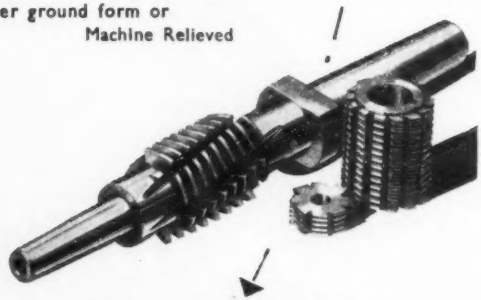

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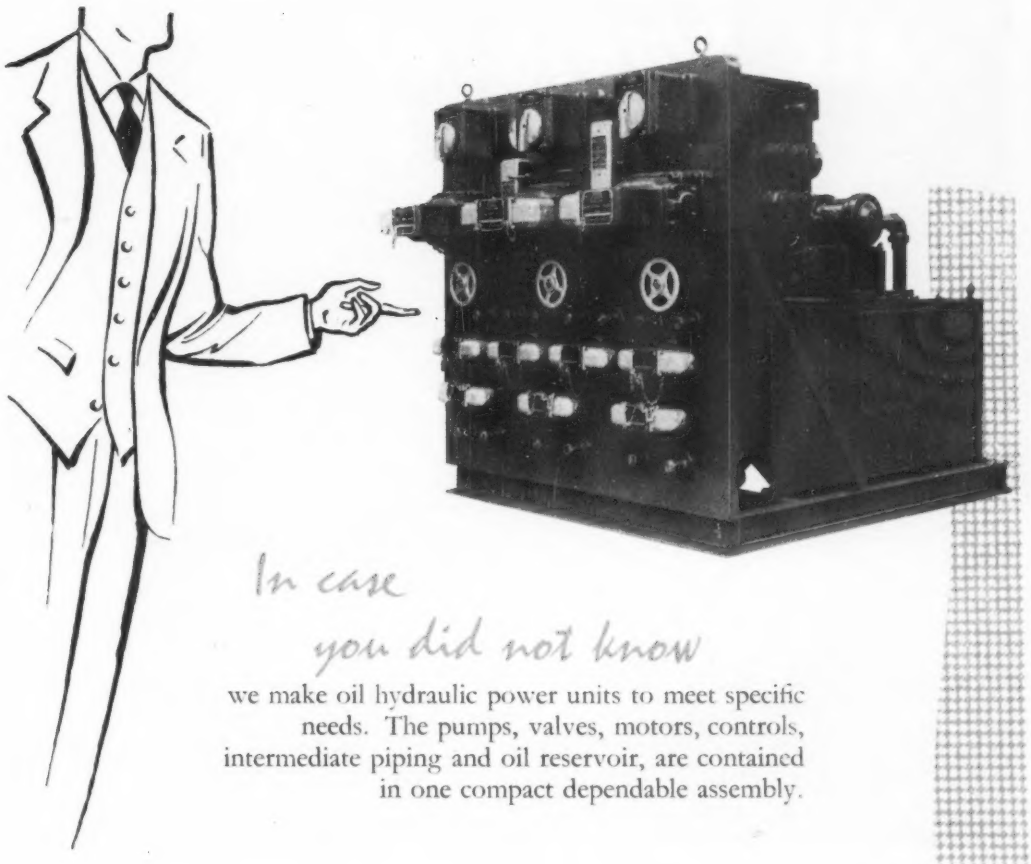

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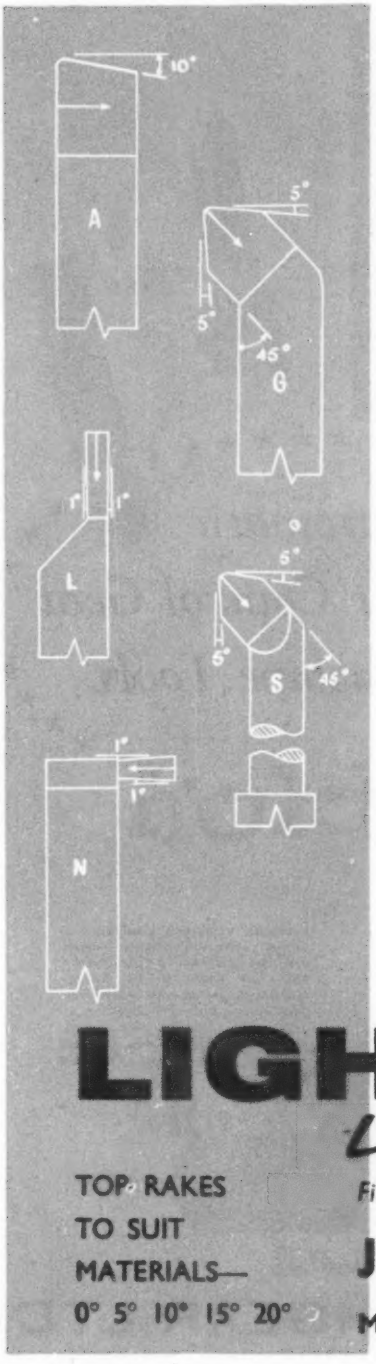

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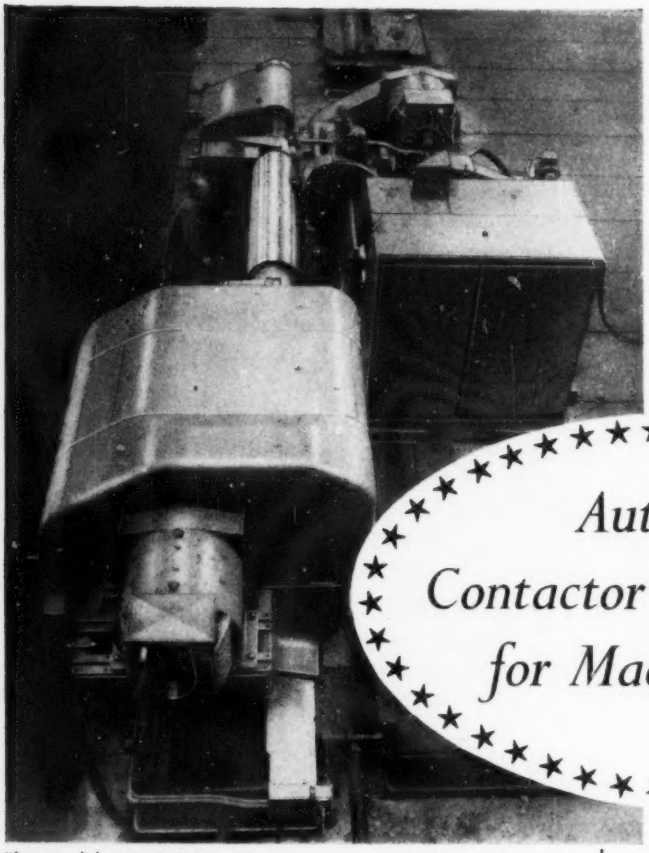

Automatic Contactor Control Gear for Machine Tools

Photograph by permission

The illustration shows a **Churchill heavy duty roll grinding machine** supplied to the Steel Company of Wales complete with Contactor Switchgear Limited Cubicle controlling 11 A.C. and 3 D.C. drives, very wide speed variations of the carriage motor being provided by Ward Leonard control. The control and indicating panel is mounted at the rear of the cubicle adjacent to the operator.

Contactor Switchgear Limited manufacture automatic electric control gear (up to 6,600v. A.C. and 650v. D.C.) for Water Works, Sewage Works, Power Station Auxiliaries, Steel Works, Rolling Mills, Chemical Plants, Gas Works and Cement Works, including Cranes, Electric Furnaces, Machine Tools, Fans and Pumps.

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hold it!

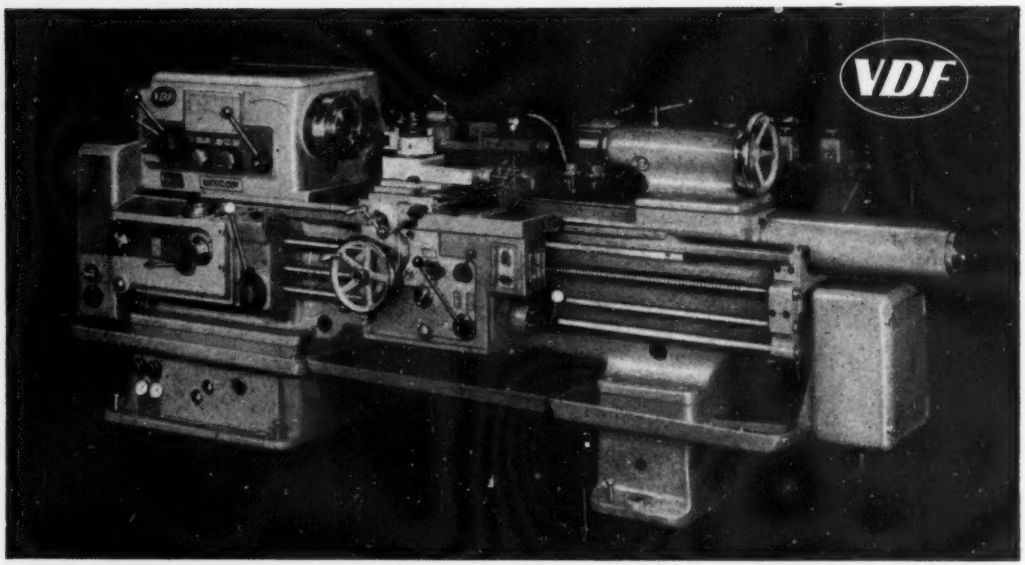
with Eclipse TOOL HOLDERS

There can be no tool bit chatter or loss of rigidity with Eclipse tool holders. The patent clamp grips along its full length, exerting pressure both downwards and sideways, to hold the tool absolutely rigidly.

Made in right-hand, left-hand and straight patterns in two sizes - $\frac{3}{16}$" to $\frac{1}{2}$" and $\frac{5}{16}$" to $\frac{3}{4}$". Other models for American type tool posts in four sizes - $\frac{1}{4}$" to $\frac{3}{16}$" - $\frac{3}{16}$" to $\frac{1}{2}$" - $\frac{5}{16}$" to $\frac{3}{4}$" and $\frac{3}{4}$" to $\frac{1}{2}$". Also cutting off tool holders in three sizes - $\frac{1}{2}$" to $\frac{3}{4}$" - $\frac{11}{16}$" to $\frac{7}{8}$" - 1" to 1$\frac{1}{4}$".

Made by James Neill & Co. (Sheffield) Ltd., and obtainable from all tool distributors

UTH7



Ultra-Sensitive Multi-Purpose VDF Unicop I Copying Lathe

- So sensitive it can produce a sphere.
- Ideal for workshops where a single-purpose copying lathe would be uneconomical.
- For normal *and* copy turning.
- Suitable for longitudinal, external and internal copying and face copying.
- Electronic-hydraulic.
- Copying traverse up to 29½" and cross copying to 5". Increased if required.
- Can be delivered with high-speed headstock (top speed up to 5,600 r.p.m.).
- Also available Unicop III for production copying and Unicop V giving greater capacity for shaft work.

BRIEF SPECIFICATION
(3 models available)

■ swing over bed	20½"	20½"	26½"
■ centre distance (normal turning) up to	118"	118"	118"
■ max. copying length	39½"	39½"	39½"
■ height of centres	10"	10"	13"
■ main spindle bore	2½"	2½"	3"
■ no. of speeds	30	18	18
■ speeds r.p.m.	9–1800	22.4–1120 28 –1400 35.5–1800	11.2–560 14 –710 18 –900
■ motor h.p. up to max.	26	19	32

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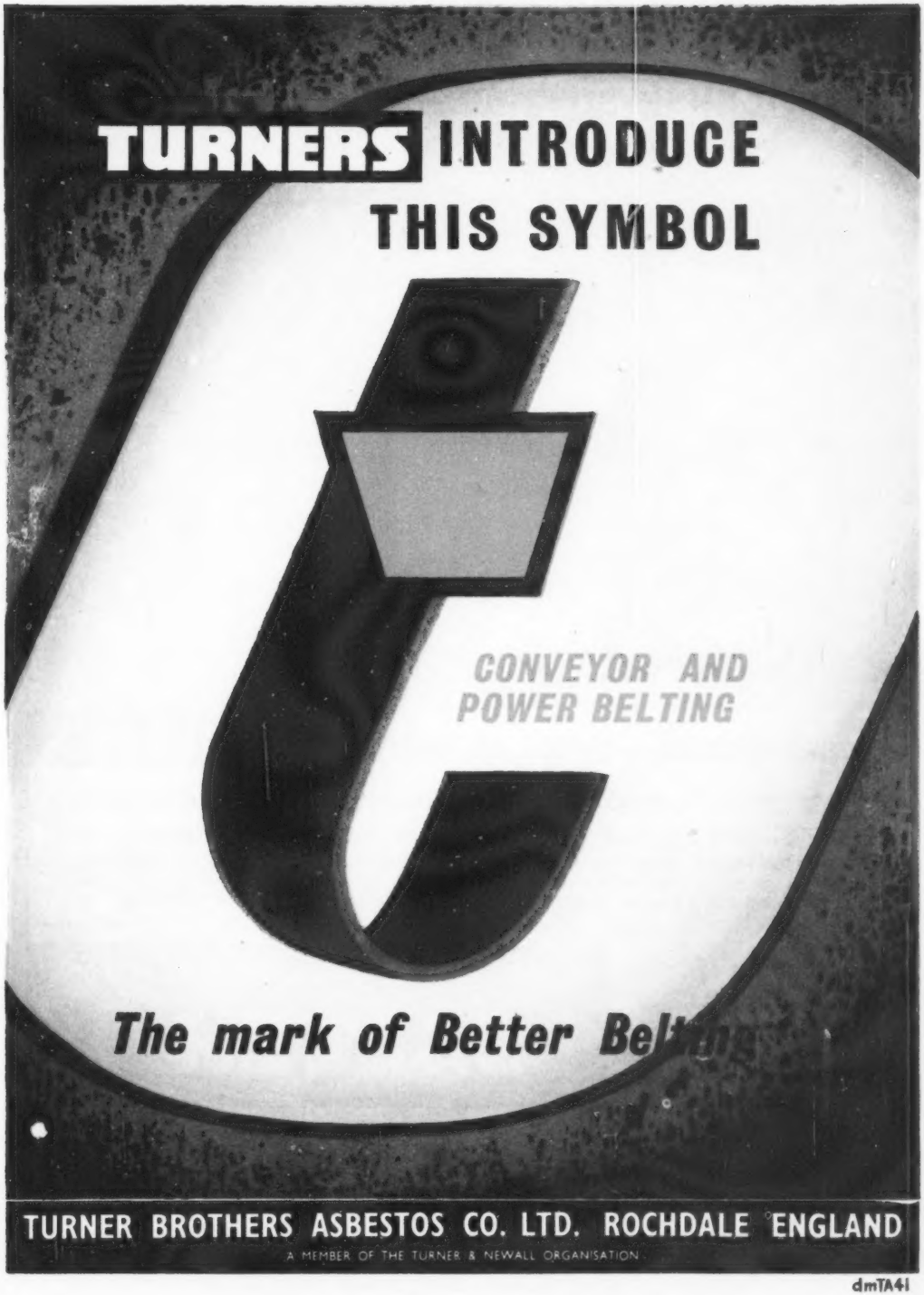
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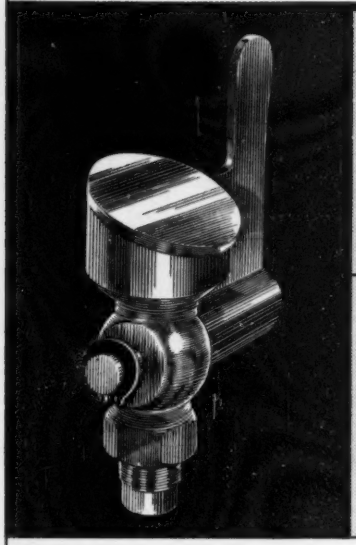
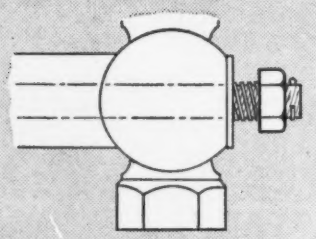
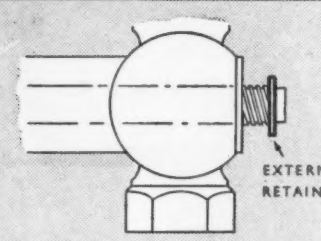




OLD WAY
To provide a shoulder for the tensioning spring on this filler cup entailed an extra long, threaded shaft, a nut, a hole drilled to take a cotter pin and an altogether tedious assembly.



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The spring is quickly positioned on a shorter, **PLAIN SHAFT** by a ***Grip Ring*** which is snapped into position for secure, frictional grip. No groove required.

save material—reduce assembly time—cut costs

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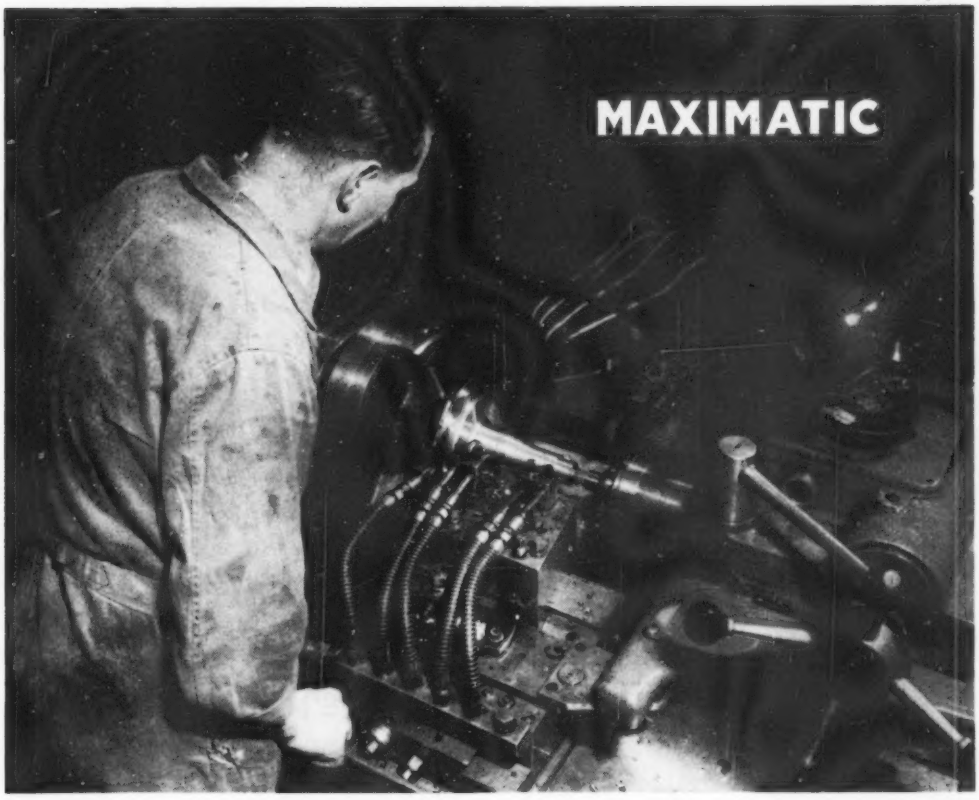

Automatic multi-tool lathe for high-output production

This illustration shows the Maximatic Automatic Multi-Tool Lathe turning axle swivel forgings, requiring several diameters, and facing.

Once set, a single lever operates the machine for each cycle, and high-output, accurate production is only a matter of load and unload. Adaptability in the setting of the cross-slides to a large extent governs the usefulness of a machine of this type and the Maximatic scores heavily in this respect. Each cross-slide is independently operated by flat former plates so that adjustment to new jobs can be made easily, and by suitable setting of cams in the feed box a variety of movements can be obtained.

Maximatics are available in a range for work up to 11in. centre height by 78in. between centres. Write today for full details

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Designed out of forty years' experience, devoted to cold sawing problems, the Model AL/CC, with its proven "Fluifeed" hydraulic feed, ample power and "Insto" segmental saw, is setting up the highest standards of performance on bars, billets and sections.

7 STANDARD SIZES

Saw blades from 11in. to 72in. dia. for sawing work 1in. to 26in. dia. Machines can be supplied as standard or with automatic bar feed.

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New vice which can grip on both sides of the saw blade, giving burr free cuts. Patent applied for.

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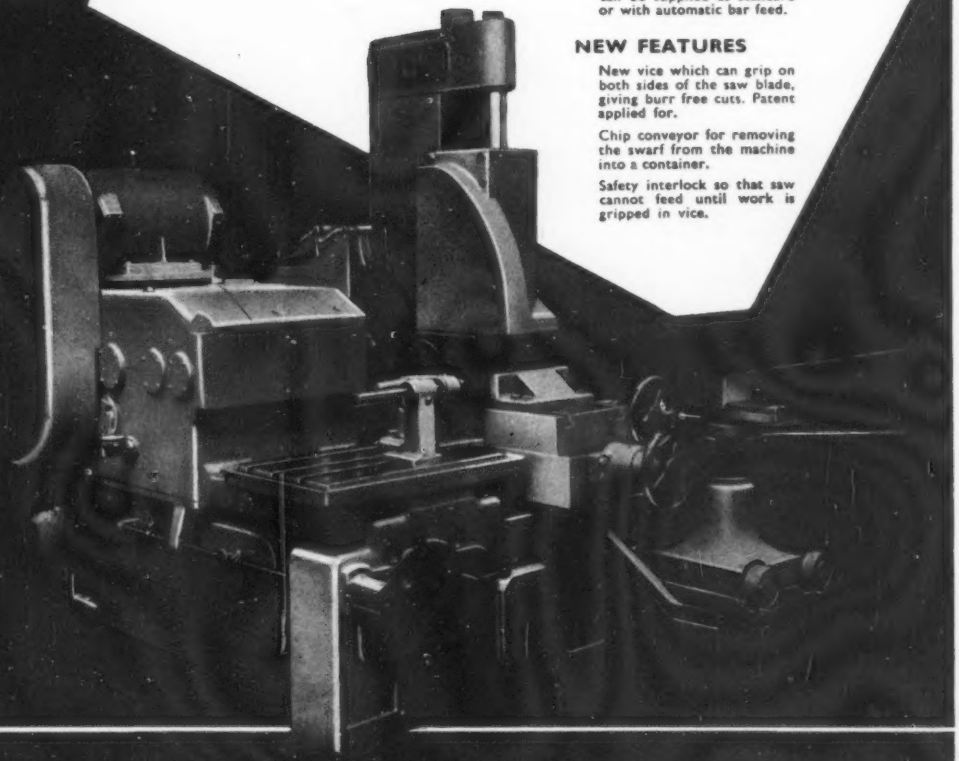

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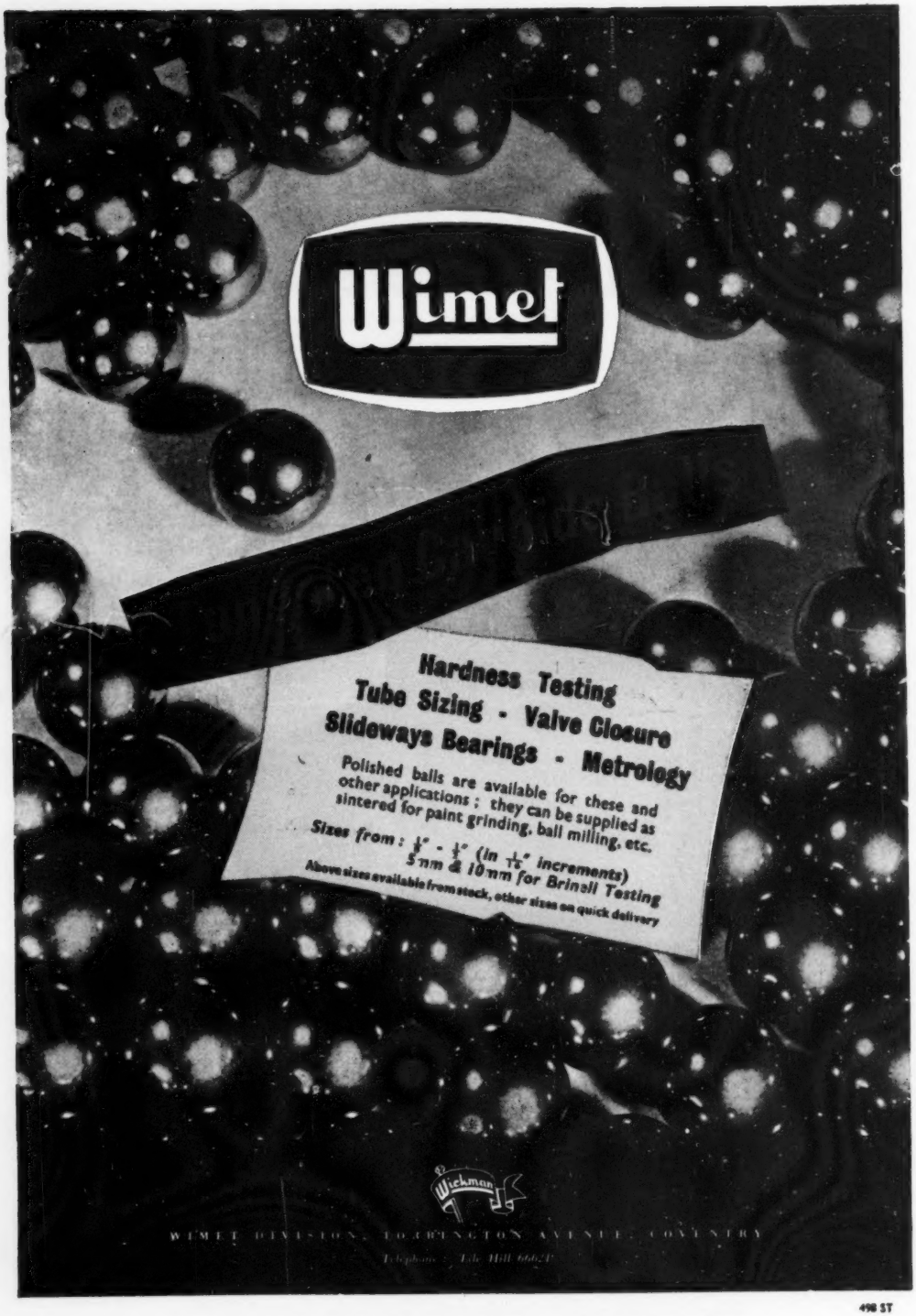
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Abstracts of Principal Articles

Machining Blades for Gas Turbine Units P. 1392

In this article, which is one of a series describing the methods employed by the B.R.D. Co., Ltd., for the production of gas turbine blades under contract, operations on Nimonic blades are first considered. These blades are machined from semi-precision forgings, and at an early stage the fir-tree serrations are milled, and then finish-ground on a special Matrix machine, details of which are given. The machine has twin wheel-heads equipped with crush-dressing units, and the blades are carried upwards between the formed wheel faces on a hydraulically-operated slide. Aerofoil surfaces on certain of these blades are next machined on standard shapers adapted for copying the forms from masters by the addition of hydraulic tracing valves and air equipment. Broaching of fir-tree root serrations on compressor rotor blades of stainless steel is then considered. After certain preliminary operations, the blade is broached, in a 3-position fixture, on the sides and end face of the root. A second machine, equipped for hydraulic copy-broaching, is then employed to broach the V-surfaces to receive the serrations, and the under-side of the platform with a concave curvature. Another machine cuts the fir-tree serrations, and the final series of broaching operations, performed on a 3-position machine, is concerned with the end faces of the root which are of complicated form. (MACHINERY, 93—17/12/58.)

Indenting Equipment and Applications P. 1405

In this abstract of a paper which was presented at the Conference on Technology of Manufacture held by the Institution of Mechanical Engineers, information is provided on the loads required for indenting various metals with characters of different sizes and with deep and shallow impressions. Some typical indenting operations are then considered, together with examples of modern equipment including a hydraulic press, with a vibratory feeder, for automatically marking ball bearing rings; a semi-automatic machine for indenting engine valve stems; and a machine for automatically indenting part numbers on thin-walled tubes. Other sections are concerned with notch effects on indented parts, and die design and production. (MACHINERY, 93—17/12/58.)

Roto-Finish Chip Separating Equipment P. 1409

The equipment here described includes a mechanical separator, which incorporates a frame carrying an interchangeable wire mesh screen. This frame is supported on helical springs and is vibrated, at a fixed amplitude, by means of an electrical unit arranged for push-button control Another separator, of the magnetic type, is provided with an under-feed drum, to the lower side of which the charge is fed from a vibrating hopper by way of a control gate. The drum, which is made from non-magnetic material, contains a fixed permanent magnet. Parts retained by the magnetic field are carried round by the drum, and are finally released and discharged by way of a chute. (MACHINERY, 93—17/12/58.)

Erie 2,500-ton Transfer Forging Press P. 1410

Claimed to be the first of its type, this press will produce forgings for such components as connecting rods, gear blanks, and track links, on a fully automatic cycle. It is shown set up for forging track links which are delivered by conveyor from a furnace. A further mechanism positions each blank between the first of three pairs of gripper jaws. As the press ram rises, the jaws move inwards to grip an ejected forging, a partly-formed component and a blank. Next, the jaws are moved to the right, and opened, to discharge the finished piece and transfer the partly-formed component and the blank to the roughing and finishing dies. (MACHINERY, 93—17/12/58.)

High-output Machining Set-ups for Cylinder Lock Components ..... P. 1412

Large numbers of die castings are employed in the production of cylinder locks at the Yale Lock and Hardware Division, Yale & Towne Manufacturing Co., U.S.A. Although the castings are produced to close tolerances, all require flash removal and many need some additional machining operations. Five closely-spaced tumbler holes are cored in lock cylinders, and are trued by a special air-operated tool, which also removes flash from a rectangular opening. After broaching, the cylinders are passed to a light duty drill press fitted with a Bellows air-feed unit whereon the main bore is reamed and spot-faced at one end. Special arrangements are provided to maintain a close tolerance between the machined face and a recess at the opposite end. Five tumbler holes are drilled through a deck lock plug on a drill press fitted with a sliding work support and jig plate which is traversed sideways by hand. Key slots are broached in cylinder lock plugs on a special machine equipped with an automatic indexing fixture. Special machines have been developed for milling the slots in cylinder lock keys and each machine is magazine loaded. (MACHINERY, 93—17/12/58.)

Gear Calculations Simplified by the Use of Williamson Tables..... P. 1416

It is explained in this article how tables compiled by Mr. J. L. Williamson of the Fellows Gear Shaper Co. can be employed to facilitate various gear calculations. Originally, these tables were prepared to permit easy determination of the centre distances to be employed between work gears and a known master gear. They will also be found convenient for such purposes as obtaining effective tooth thickness at various diameters, finding the centre distances for gears of known arc tooth thickness, estimating distances over or between precision measuring pins, and solving for a new centre distance or ratio. (MACHINERY, 93—17/12/58.)

Developments in Machine Tool Control

During the course of a paper read recently before the Manchester Association of Engineers, The Rt. Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P., drew attention to the possibilities and limitations of some of the control systems which are now available for application to machine tools, and to the problems associated with their effective exploitation. The title of his paper was "Electro-mechanical Themes in Machine Tool Design," and in the introduction he pointed out that many techniques now contemplated for use in conjunction with machine tools were quite foreign to the skills traditionally associated with the industry. In some instances these techniques represented "the overflow of advances in other branches of technology having no initial or ostensible connection with the machine tool industry." Later, Lord Halsbury expressed the opinion that it would be unfair to criticize the industry because "these exciting new developments have all been introduced to it from outside." It was unreasonable, he suggested, to expect any one industry to undertake research in every field, in the hope that some by-product might have "some quite unlooked-for relevance to its domestic interests." As examples, reference was made to "a highly original AA predictor" which had many of the properties required in a computer for use in connection with a control system, and to the diffraction gratings now effectively employed for measurement which were "a by-product of research into pure optics and spectroscopy."

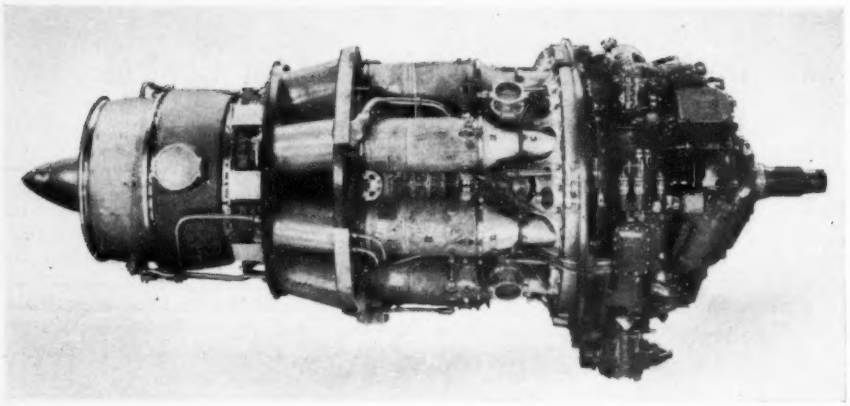
When an industry was revolutionized from outside, moreover, it required a breathing space "to digest new potentialities" and if, during this period, it appeared to be lacking in initiative, the reason might lie in the fact that it was "almost completely unstaffed in respect of specialized exponents of some exotic technique or other." As a result the industry might see "a temporary initiative pass into the hands of strangers", but it was essential that this initiative should be recaptured with the minimum of delay.

Emphasis was given to some of Lord Halsbury's remarks by certain of the exhibits at the Electronic Computer Exhibition which was held at Olympia. As is well known, leading companies in the electronic field have been concerned for several years with the development of systems for obtaining automatic positioning or continuous control of movement, also for controlling other functions to permit fully automatic machine operation. To overcome inevitable mechanical deficiences, various ingenious measuring arrangements have been introduced to enable work to be machined to the high degrees of accuracy now necessarily demanded. Some of these arrangements have already very successfully withstood the test of practical application and others are still the subject of investigation. If the mechanical features of machines could be made to function perfectly, there would be no need for these monitoring systems which provide for independent control of precision. The fact that such independent control can be achieved, however, may prove to be of importance for purposes other than positioning.

In this connection, Lord Halsbury drew attention to the far reaching implications of being able to work with "an absolute co-ordinate system external to the stressed frames and slideways which support work and tool-holders." It should be possible, for example, as Dr. Koenigsberger has intimated, to apply correction movements to one slide in order to compensate automatically for any errors in the motion of another slide in a direction at right angles.

Clearly, if full advantage is to be taken, without undue delay, of all the possibilities now afforded for improvement in machine tool performance, as a result of advances in the electrical and electronic fields, closer co-operation will be necessary in the future between those responsible for the purely mechanical features on the one hand and the electrical and electronic circuits and equipment on the other. For some purposes it is probable that the wholly mechanical arrangement, as represented by the cam and follower, will continue to be preferred, but with the inevitable growth of complexity of function increasing benefits will be derived from the ability to transmit power and control signals through different channels. "Somewhere between the limits of extreme simplicity and extreme complexity," said Lord Halsbury, "a break-even point must occur at which the purely mechanical solution should pass over into an electro-mechanical one. A common error in assessing invention is to suppose that the inventor has necessarily made a correct assessment of such a break-even point. If it can be shown that the application of his invention is uneconomic,

(*Continued on page* 1437)



Machining Blades for Gas Turbine Units

Methods Employed by the B.R.D. Co., Ltd., Aldridge, Staffs.

Articles published in MACHINERY, 92/1082—9/5/58, 93/400—20/8/58, and 93/976—29/10/58, have been concerned with the methods employed by the B.R.D. Co., Ltd., a member of the Guest, Keen & Nettlefolds Group, for producing blades for gas turbine units. These articles described machining operations on precision-forged blades of aluminium alloy, and rough-forged blades of stainless steel, including the production of dovetail root forms, and aerofoil surfaces on Jameson abrasive band-type and Ex-Cell-O machines. The preparation of master cams for Ex-Cell-O machines by means of an automatic tape-controlled milling machine, and a copy-milling machine employing the spark-gap principle, was also discussed. Here, some typical operations on turbine rotor blades, which are machined in most of the Nimonic series of heat-resisting alloys, are covered.

Among the many engines for which the company supplies blades is the Bristol Proteus, the No. 755 variant of which is seen in the heading illustration. This engine, which powers the Bristol Britannia, develops a maximum of 4,120 h.p., and is of unusual design in that the air is drawn in near the rear end, at the left in the illustration. Passing through the compressor in the direction of the propeller shaft, the air is compressed and then passes to the flame tubes by way of a final, centrifugal, compressor stage. From the flame tubes, the gases are led first through a high-pressure 2-stage turbine, with shrouded blades, which drives the compressor rotor, and then through a low-pressure 2-stage turbine whereby the propeller shaft is driven. The compressor and propeller shafts are co-axial but are independent of each other, and great flexibility in operation under varying conditions is thus afforded.

The two stages of the high-pressure turbine and the first stage of the low-pressure turbine are shrouded, the blades being made with small platforms at their outer ends which confine the gas flow. The final turbine stage, at which the pressure is lowest, is not shrouded, and it is blades of this type that will be considered in this article. The examples shown in Fig. 1 illustrate the sequence of operations employed in machining the aerofoil portions of a Proteus blade which is made from the forging, seen, with only the root end and location pip machined, at the left. A completely finished blade, trimmed to the required length, is shown at the right.

OPERATIONS ON NIMONIC TURBINE BLADES

As explained in the second of the articles mentioned, the normal procedure for machining a blade from a rough, as opposed to a precision forging, on which the aerofoil portion requires no further machining, is to finish the root end first. A pip, provided for the purpose on the end of the aerofoil portion, is machined and employed for locating and clamping that end of the forging during the operations on the root. The first step in machining

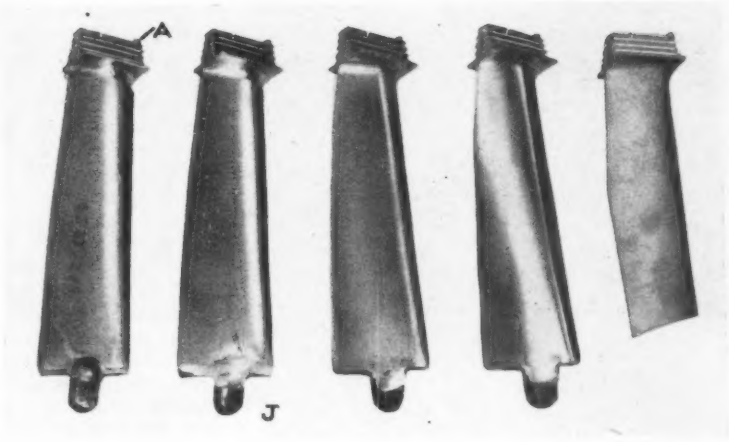


Fig. 1. Examples of Bristol Proteus low-pressure turbine blades machined from Nimonic 90, on which the aerofoil surfaces have been formed by copy-shaping

the root portion of a blade of the type shown in Fig. 1 is to grind both long sides of the root platform parallel to each other, also to grind the sides of the tip locating pip, parallel to those of the platform. For these operations, the blade is held in a box-shaped fixture in which it is located from the rough aerofoil surfaces and clamped between pads of suitable shape.

Grinding is performed on Ex-Cell-O machines of the type described in the first article (MACHINERY, 92/1090—9/5/58), which have two wheels on vertical axes. The box fixtures are clamped to a slide which passes between the wheels, on an automatic cycle, and the wheels are fed inwards by controlled amounts after each pass. Examples of these box fixtures, which are employed on other grinding machines in the plant, are seen in Fig. 4, with blades at a later stage of production. From the Ex-Cell-O machines, the blades are transferred to a Lumsden rotary surface grinder on which the leading edge of the blade, extending to the side of the root portion is first ground, and then the trailing edge, in alternate fixtures on the circular table.

In each fixture of the first set, the blade is located from the previously-ground root faces and from the platform face in the end-wise direction, and is clamped by carbide-faced pads on the sides ground at the preceding stage. Location for grinding the trailing edge is taken from the leading edge when the blade is transferred to a second-operation fixture. A Jowitt R36K, 6-piece segmental wheel of 14 in. diameter is employed. A grinding operation on an Ex-Cell-O 85 machine is next

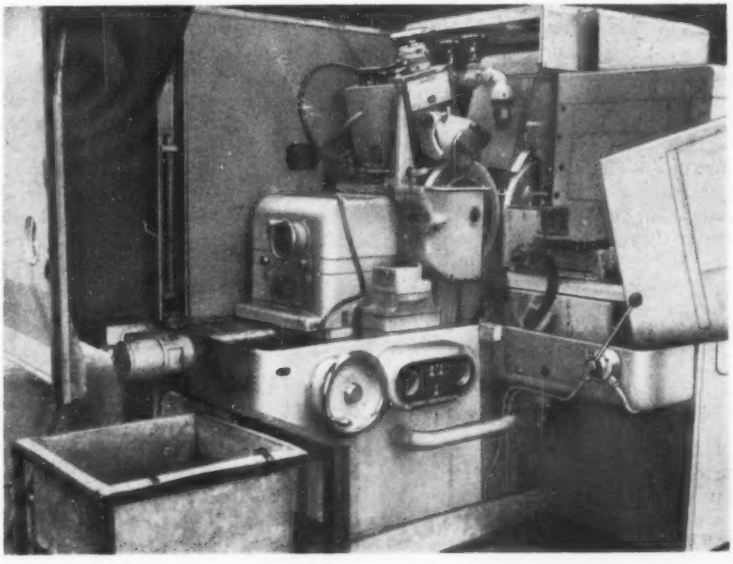


Fig. 2. Finish-grinding of the fir-tree root serrations on the blades in Fig. 1 is performed on this special Matrix form-grinding machine equipped with twin wheelheads and crush-dressing units

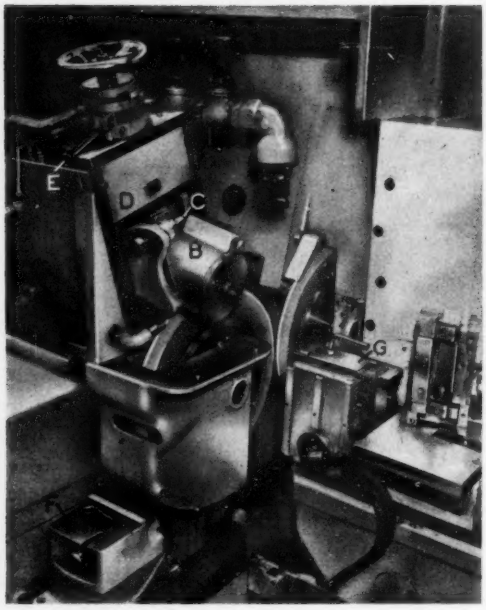


Fig. 3. Close-up view of the Matrix grinding machine showing one of the crush-dressing units in which a crushing roll of tapered form can be set accurately at the required angle

performed on the locating pip at the end of the aerofoil portion to produce a square section whereby the end of the blade may subsequently be rigidly supported and clamped. Milling operations are next carried out on the root portion for facing the ends at the required angles and milling the extreme end face, leaving the location tang *A*, Fig. 1. A narrow slot is also milled in the end face at this stage.

Form-milling cutters are then employed to rough-machine the fir-tree serrations and the under-side of the platform, on one side of the root at a time, and these serrations are subsequently rough- and finish-ground on a special Matrix (Coventry Gauge & Tool Co., Ltd.) machine of the type seen in Fig. 2.

MATRIX ROOT-FORM GRINDING MACHINE

This machine, which is shown with the guards in the open position, is designed for semi-automatic operation, and has two wheel-heads carried on slide-ways on the box-section base. Each wheel-head can be adjusted towards or away from the machine centre, and can also be independently adjusted transversely and for angle of the wheel, as required. Each spindle is driven by a separate 5-h.p. motor and can be fitted with a wheel up to 18 in. diameter by 2 in. face width. For Nimonic 90 material, the Norton grinding wheels are of specification 38A-1804-L9-VBE, and they are driven at a speed of 1,500 r.p.m. Each wheel-head is fitted with its own crush-dressing unit which is seen in position above the left-hand wheel in Fig. 3. The dressing unit incorporates a tapered crushing roll on which a fir-tree form is produced, with the aid of a Diaform (L.M. Van Moppes & Sons, Ltd.) pantographic forming attachment, on a universal grinding machine in the toolroom.

This crushing roll is carried on a spindle within the housing *B*, Fig. 3, which is pivoted near its lower end and can be clamped in any desired position, within its range of adjustment, by means of a stud and slotted bracket at the left. Setting of the axis of the crusher roll to the angle specified for a particular blade root is facilitated by the provision of the small cylindrical roll *C*, the axis of which is located accurately at a distance of 5 in. from that of the pivot axis for the housing, to form one leg of a sine bar. The angle is set with the aid of a stack of slip gauges which is interposed between the roll *C* and a flat surface on the vertical face of the main support casting *D*. With this type of crush-dressing unit, the action between the roll and wheel surfaces may be likened to that of a pair of acute angle bevel gears, and skidding, with consequent rapid wear of the roll, is thus avoided.

For the crush-dressing operation, the support casting *D*, which is held in V-ways on the face of the main casting, is fed downwards to bring the roll into contact with the stationary wheel, this initial adjustment being effected by means of the handwheel at the top of the unit. Pressure exerted by the feed screw is transmitted to the slide *D* through six coil springs, and, when the required force is exerted, a switch is operated to complete a circuit to a small motor which drives the wheel slowly for the dressing operation. A wire brush in the roll housing removes any adhering particles broken from the wheel surface. The downward feed of the crushing roll can be applied in increments ranging up to 0·004 in. per rev. of the wheel, or it can be fed continuously at a very slow rate. Selection of the type of feed to be applied is made by means of the lever *E*, in conjunction with a rotary selector switch on the front of the machine base. It will be understood that the form ground on the crushing roll is so orientated that when it is fed down vertically, while set at an angle, the desired profile is produced on the wheel.

As an alternative to crush-dressing, where the

quantities of blades required are so small as to render the production of crushing rolls uneconomic, a special diamond dressing attachment can be mounted on the flat surface *F*, at the rear of the wheel, and applied through the slot in the guard.

To the right of the wheels, there is the slide on which the fixtures carrying the blades are hydraulically clamped, as seen at *G*, the ram of the cylinder being equipped with pressure-equalizing bars which make contact with the vertical face of the box. Location for the fixture in all three directions is provided by stops on the slide, and the box must be correctly positioned, so that it operates a microswitch, before the automatic cycle can be initiated.

The slide carrying the box fixture has movements in both the vertical and horizontal planes, and during the automatic grinding cycle it is first fed towards the wheels until the root end of the blade, projecting from the front vertical face, is aligned with the gap. Upward movement of the slide then carries the blade between the wheels for the grinding operation, which can be performed at a traverse speed between 0·3 and 3 in. per min., depending on the amount of metal to be removed. Since only a small amount of material is left on the root surfaces at the milling operation, grinding is normally carried out at the highest rate mentioned. The slide then retracts to carry the blade clear of the wheels before being lowered to the loading position. All the slide movements, with the exception of the grinding pass, are carried out at fast traverse rate, to reduce the total cycle time.

During grinding, a copious flow of Vaughan's Frapol T.G. special cutting oil is supplied to the wheels from a pump having a capacity of 24 gal per min., and the oil mist generated within the machine guards is removed through ducting, which is connected to a large-capacity Precipitron (Sturtevant Engineering Co., Ltd.) electrostatic precipitation filter unit, whereby the oil particles are efficiently removed from the air before it is discharged. Cutting oil circulating in the machine is passed through a Barnesdril Gaston E. Marbaix, Ltd.) magnetic separator and settling tank for the removal of metallic particles and grit.

Further details of the box fixtures in which the blades are held may be seen in Fig. 4, which shows the two fixtures normally provided for each type of blade. Unloading and loading of one fixture can thus be carried out during the grinding cycle of the machine, and the fixture at the right is shown with a blade in position, but unclamped. A blade is placed in position with the locating pip at the aerofoil-end in V-locations and with the end surface in contact with a spring-loaded plunger in the fixture base. This plunger thrusts the blade endwise so that the machined end-face of the root is held in contact with the under-side of the inverted L-shaped projection *H*, which provides location in this direction. The root end of the blade is further positioned by means of carbide-faced pads on each side, and one long platform face rests against a carbide-faced surface at the upper end of the fixture.

There are two hinged clamps for securing the blade, and the lower clamp has a pad of appropriate form to engage the face of the aerofoil pip, and the upper, a pad which makes contact with the other long platform face. Both clamps are then tightened with the aid of stirrups, as at *J*, which are fitted with socket grub-screws whereby pressure is applied with the aid of a key. Each clamp incorporates a sliding pad of wedge form with a T-slot in the end surface, and after the stirrup has been

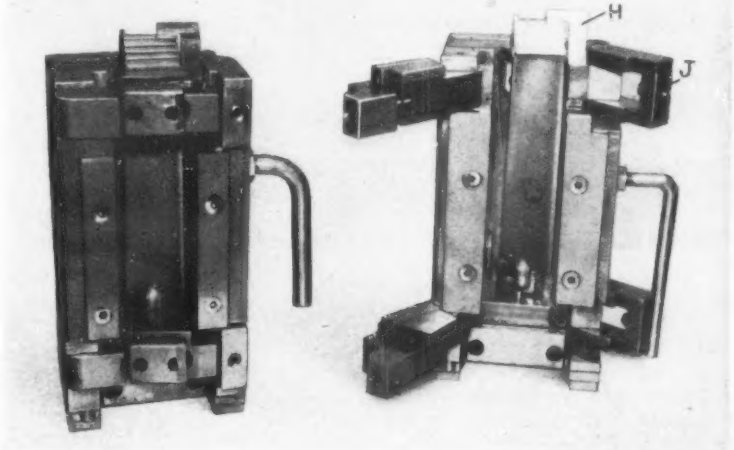


Fig. 4. Box-type fixtures employed on the Matrix machine, one of which is shown with the clamps free for loading. The blade is thrust endwise by a spring plunger against a face on the projection *H* for location in this position

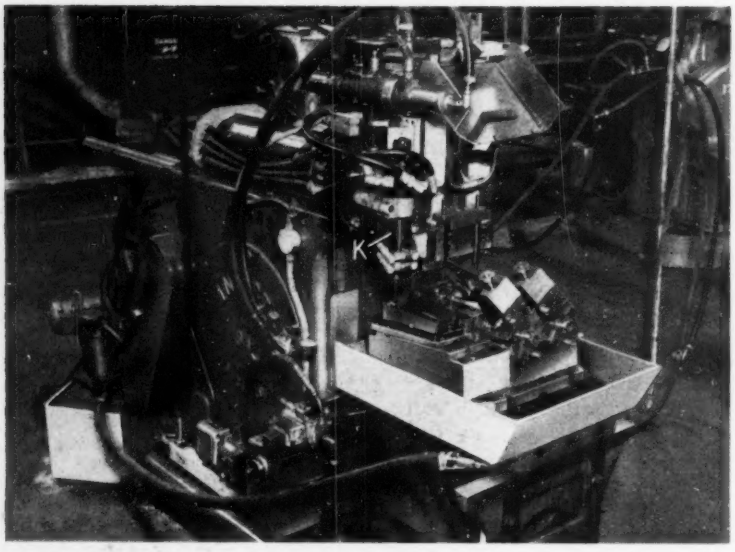


Fig. 5. General view from the left-hand side of an Invicta machine equipped for the copy-shaping of aerofoil surfaces. The tracer valve *K* controls the height of the tool-holder slide above the work

clamped in place, a socket screw, with a T-shaped end which engages this slot, is drawn up to apply the final clamping pressure. The surfaces of the pads are also carbide-faced to enable them to withstand the extremely abrasive action of the Nimonic material. After rough grinding has been completed on a batch of blades, the wheels are dressed and the root forms are ground to the required finished size at a second stage.

Next, the aerofoil side of the root platform face of each blade is milled. This face must be blended with the aerofoil itself, and this operation may be performed on a pair of conventional horizontal machines equipped with Bridges Copymil hydraulic copy-milling attachments, as described in the last of the articles mentioned earlier. For this method, separate set-ups are required for the concave and convex sides of the blade, and the leading and trailing edges may require a certain amount of hand-blending. Where the aerofoil surfaces are to be produced by means of a copy-shaping technique, as will be described, the location pip at the end of the blade is ground carefully away on each side to enable the cutting tools to reach to the blade end without fouling the pip. Blades on which the relief grinding operation has been completed are seen in Fig. 1.

COPY-SHAPING OF AEROFOIL SURFACES

Because of certain difficulties associated with the machining of the harder or tougher Nimonic alloys on the established aerofoil generating machines described in earlier articles, the design and development department of the company has long been engaged in investigating alternative methods. One result of this research has been the conversion of standard Invicta 6M (B. Elliott & Co., Ltd.) mechanical shaping machines for the automatic production of the desired forms under hydraulic control. Several machines have been equipped for this work, and an example is seen in Fig. 5, set up for the roughing operation on the concave side of the blade.

The conventional tool-holder and adjusting slide has been removed from the end of the shaper ram and in its place is fitted a special unit with a vertical slide operated by an integral hydraulic cylinder, the ram of which is fixed. This slide carries two tool-holders, each with provision for individual adjustment of the tool at its lower end, so that two blades can be machined simultaneously. The support casting for the vertical tool-holder slide has dovetail ways at one side, to receive a slide which can be moved up and down by means of a screw. Brackets on this slide carry a Hayes Hydrotracer hydraulic tracing valve *K*, which is supplied from a self-contained hydraulic pump unit on the floor at the rear of the machine, and serves to control the vertical movements of the tool-holder slide.

A close-up view showing the arrangement is given in Fig. 6, where the bracket supporting the copying valve is indicated at *L*. The slide carrying this bracket is adjusted vertically by means of the hand-wheel *M*, at the top, to bring the stylus *N*, projecting from the lower end of the copying valve, into contact with the master form *P*, secured to the machine table. When the stylus is in contact with the form, and the valve and its cylinder are in equilibrium, raising of the valve body, by

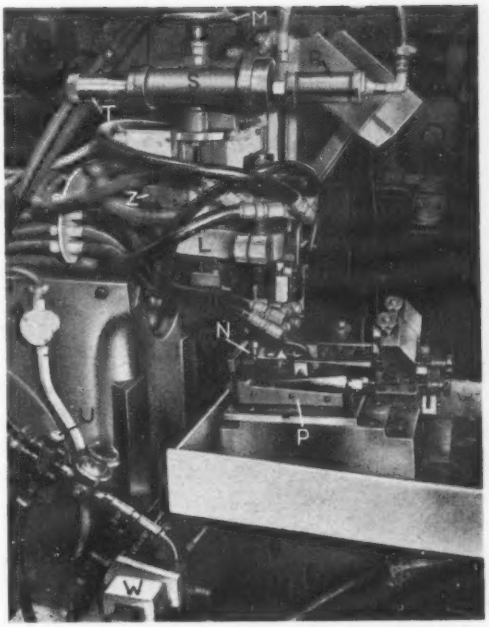


Fig. 6. In this close-up of the copy-shaper head, details of the mounting of the tracer valve and the mechanism for applying increments of down-feed to the tools can be seen

means of the screw, will result in lowering of the tool-slide so that a deeper cut is taken. Application of increments of feed at the end of each traverse across the form is effected by means of the air cylinder *R*, the ram of which is connected to a ratchet mechanism within the housing *S*.

Increments of feed up to 0·015 in. can be applied with this mechanism, the amount of increment being adjusted with the aid of the screwed sleeve *T*, which limits the movement of the air cylinder ram and consequently determines the number of ratchet teeth brought into operation. The cylinder *R* is connected to a Maxam pilot valve *U*, which is connected to one of two push-button valves on a bracket *W*, at the left-hand end of the table ways. Two similar valves are fitted at the right-hand end of these ways, and a pair of valves is operated by an adjustable stop on the side of the table as the latter approaches the end of its cross traverse. Another view of the machine, from the right-hand side, is given in Fig. 7, and shows the hydraulic pump unit for the copying valve at the extreme right, also details of the equipment whereby the cross-feed and clutch mechanisms are operated.

To the end of the cross-feed screw is fitted the box-shaped unit *X*, which has an air cylinder at the top to vary the position of the ratchet pawl when the direction of feed to the table is to be changed. This cylinder is connected to an automatic air-operated valve *Y*, and this valve, and the pilot-operated valve *U* in Fig. 6, are actuated by the pairs of push-button valves when the plungers of the latter are depressed by the table stops. As a result, the direction of the

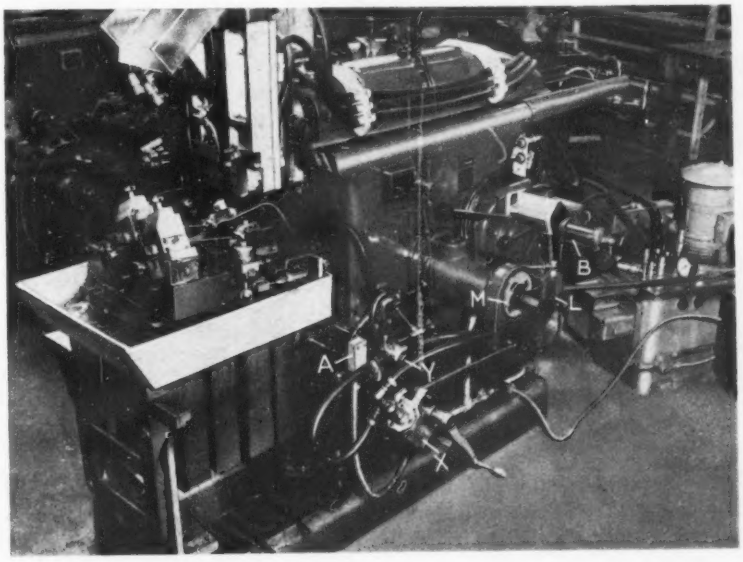


Fig. 7. Further details of the copy-shaping machine are shown in this general view from the right-hand side. The hydraulic pump unit for the tracer mechanism is seen on the floor at the extreme right

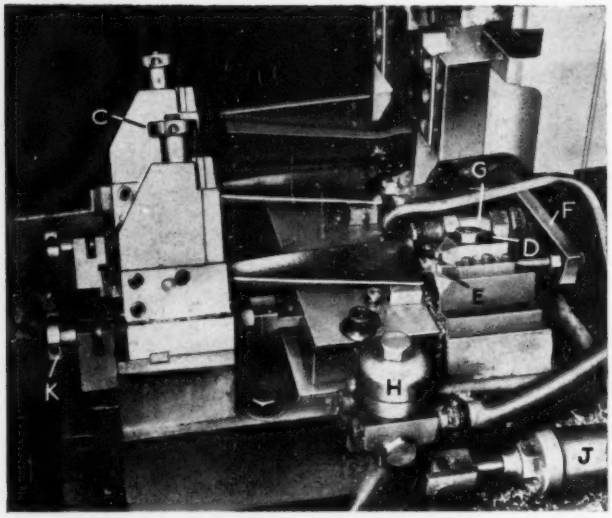


Fig. 8. Two blades are loaded into the fixture and the root serrations gripped in jaws at the left, which have matching serrations. The square sides of the aerofoil locating pip are gripped by a clamp at the right

table movement is reversed, and a small downward feed is imparted to the tool-slide in readiness for the next pass across the blade.

As previously explained, the valve body, on its slide, is moved upwards by the ratchet in order to apply increments of feed to the tool in a downward direction, and it carries a projection Z, Fig. 6, with an adjustable stop. Above this stop there is a micro-switch, and when the limit of downward movement of the tool has been reached, the switch is operated. If, at this point, the table is at the left-hand end of its ways, it will return to the right until it operates another micro-switch *A*, Fig. 7, to complete the circuit to a solenoid valve which is connected to the cylinder *B*. This cylinder then operates the clutch lever to disengage the drive and the machine stops. If the valve micro-switch is operated while there is a circuit through the switch *A*, because the table is already at the right, the machine is stopped immediately.

FIXTURE AND TOOLING ARRANGEMENTS

A close-up view of the machine table from the right-hand side, showing details of the duplex fixture and the two tools, is given in Fig. 8. Each blade is loaded with the root end outwards so that the cut starts at the outer end of the aerofoil and proceeds towards the root. The set-up shown provides for machining the concave side of the aerofoil, which is carried out before the convex side is shaped, and each blade is held at the root end between a fixed and a moving jaw. Each jaw has serrations to match those of the blade root, and the upper jaw can be screwed down, by means of the star-nut *C*, to grip the work. Before the moving jaw is finally tightened, pressure is applied to the further, trailing-edge, side of the root, by means of a retractable lever and a nut on its support stud, seen projecting from the body of the nearer fixture in Fig. 6, to thrust the leading-edge face of the root into contact with a datum surface on the fixture. The root end is thus accurately located in all three directions.

One flat face of the square machined on the aerofoil-locating pip now rests on a datum surface on top of a support block at the other end of the fixture, and is beneath the end of a clamp *D* (Fig. 8). The side faces of the square pip are engaged by a U-shaped slot in a retractable tongue *E*, which is connected at the rear end to a cross-bar *F*. The cross-bar is attached to the ram of a small single-acting, spring-returned air cylinder *G*, mounted between the two fixtures, so that the tongues *E* can be retracted for ease in unloading and loading. With a tongue in the position shown, the nut for the clamp *D* is tightened, and the valve *H* is then operated, to admit air pressure to the front of the small cylinder for retracting the tongues.

The same valve controls the single-acting, trunnion-mounted, cylinder *J*, the ram of which is coupled to a transverse shaft passing through the fixture. This shaft is connected to a vertical element within each fixture, which is thus raised into contact with the underside of the aerofoil portion of the blade at the pip end, to provide support against the cutting loads. This support element is then locked in place by means of a sliding wedge which is drawn towards the front of the fixture by tightening of the star-nut *K*. The cycle can then be started by the operator, who normally tends a number of these machines, and attention can then be turned to another machine. It may be noted that the fixture is tilted at an angle of about 7 deg. to the horizontal. It is thus ensured that the direction of the oil flow through the copying valve is

the same throughout the cutting stroke, and hunting is prevented.

The tools employed are made from Gillott's J36 special high-speed steel, and are accurately ground to the same nose radius as the stylus of the copying valve. Each tool is held by a hardened wedge with three socket screws, the side of the tool being ground to the required angle, and a screw is provided for setting the height. Since the angle of the front tool face relative to the surface being machined changes as it passes along the blade, this face is ground flat, and sharpening is therefore comparatively straightforward.

Cutting is performed at a surface speed of approximately 10 ft. per min., and, during the return stroke, the tools are automatically retracted slightly from the work, to avoid rubbing. This retraction is effected by means of a hydraulic valve *L*, Fig. 7, mounted on the side of the machine. The plunger of this valve projects horizontally towards a cam *M*, on the main shaft which carries the bull-wheel, and the cam is so designed that the plunger of the valve is depressed during the return stroke of the ram. When the plunger is depressed, there is a change in the flow of oil to the cylinder whereby the height of the tool-slide above the work is determined, with the result that the tools are lifted slightly, and when the plunger is released the tools are returned to their previous setting. During cutting, the tools are supplied with oil through a twin-outlet nozzle attached to the fixture is supported on the table, and runs back by gravity to the pump unit seen at the left in Fig. 5. A hinged shield of transparent plastics material is also attached to the tool slide to intercept flying chips, which leave the work at a fairly high temperature.

Normally, two or three passes across the blade are required to bring the surface to the condition seen at *J* in Fig. 1, and the components are next transferred to another adapted shaper, arranged to operate at a lower surface speed and with a smaller rate of feed, for the semi-finishing operation. A blade after this stage is shown at the centre in Fig. 1. The blades are then loaded, convex side upwards, on a third shaper, on which the roughing operation on that side is performed. Next, a finishing cut of 0·015 to 0·020 in. is taken on the concave side to remove any distortion caused by the relief of stresses when rough shaping the convex slide. The oil is confined by the tray in which the side. Finally, a finishing operation is carried out on the convex side, and, at this stage, the blade rests on a cast zinc pad of suitable form, which provides support for the entire aerofoil portion.

Inspection follows, and the aerofoil may be set by hand to the required degree of twist, if necessary, before the leading and trailing edge faces of the root are finish ground. A series of hand operations is then carried out to blend the root fillet radius with the aerofoil, and to polish out the machining lines on the aerofoil surfaces, on abrasive bobs and band-type machines. Each blade is next cut roughly to the required length, and the end surface of the aerofoil portion is finish-ground to length. Another inspection operation, performed with receiver gauges and optical projectors, is then carried out. Electro-polishing, which shows up any minute cracks in the blade, is subsequently performed, and is followed by shot-peening, stress-relieving and vapour blasting, to bring the blades to the condition seen at the right in Fig. 1, in readiness for final inspection.

BROACHING OPERATIONS ON FIR TREE ROOTS

An alternative to grinding the root fir tree form, which is extensively employed for compressor rotor blades of stainless steel, especially where sufficient numbers are required to justify the expense of fixtures and tools, is broaching. This method offers the advantages of close accuracy, extremely good

Fig. 9. General view of the Weatherley Oilgear vertical hydraulic broaching machine employed for the initial operations on stainless steel fir-tree roots, showing the automatic clamping mechanism

surface finish, and speed of production where a number of machines can be employed. The broaching department of the B.R.D. Co. is almost exclusively devoted to the finishing of fir tree roots and is equipped with a total of 21 large XS 30 × 66, Weatherley Oilgear hydraulic machines of the single slide type. These machines are arranged in two rows in the shop, facing inwards, and a common platform is provided for all the operators.

A general view of one of the end machines of a line is given in Fig. 9, and each operates on an automatic cycle which is initiated by simultaneous pressure on sleeves on two horizontal tubes *N*. These sleeves are fitted with ball-ended levers whereby they may be turned to the left or the right when it is required to inch the broaching slide down or up, the central position providing for automatic operation. A bar at the front of the machine, at the level of the operator's knee, may be pressed towards the machine to stop the slide in an emergency. Secured to the front of the machine base, there are one or more steel plates carrying cylindrical holders *P*, which house heavy coil springs. Through a hole in the end of each holder projects a pull-bar, which is connected to the spring at one end and to a lever on the fixture at the other.

This lever is pivoted in the fixture casting, and when the fixture is carried forward to the broaching position, by the machine table, the lever is turned. The upper end of the lever is seen at *R*, and when it is turned, the curved surface is moved into a position beneath the clamping lever *S*, the slotted end of which is fitted with a roller. Thus, as the fixture moves forward to the clamping position the component is automatically clamped, and when the table is retracted, it is released, ready for unloading or transfer to the next fixture position. With the table advanced, the broach slide movement is automatically initiated, and when the slide has reached the bottom of its stroke, the table is retracted for unloading.

Broach design is conventional, with tooth loadings of 0·003 in. for roughing and 0·001 in. for the finishing operations. The machines are so designed that adjustable stops on the broach slides can be set to operate switches controlling hydraulic solenoid valves, to reduce the broaching speed for the finishing stage, at any point in the stroke. For rough-broaching, a speed of the order of 14 ft. per min. is employed, and for finishing, it is reduced to about 6 ft. per min. Lubrication and cooling of the broach teeth is provided by a copious flow of Fletcher Miller's R.11 cutting oil.

Some examples illustrating a few of the successive steps required for the completion of the fir tree root on a large stainless steel compressor rotor blades are shown in Fig. 10. On the blade at the left, several preliminary milling operations have already been performed to provide location and clamping surfaces on the root end. The pip at the end of the aerofoil has been turned to a cylindrical form so that it can be employed to position that end of the blade accurately in the broaching fixtures. The machine set-up shown in Fig. 9 provides for the first three broaching operations on this blade, and Fig. 11 gives a close-up view of the fixture, from which details of the clamping arrangements may be observed.

In Fig. 11, the three positions at which the blade is successively loaded can be seen, also the main clamps and their operating levers, as described above. A fresh blade is first loaded at the right-hand position, where it is seen at *T*, and

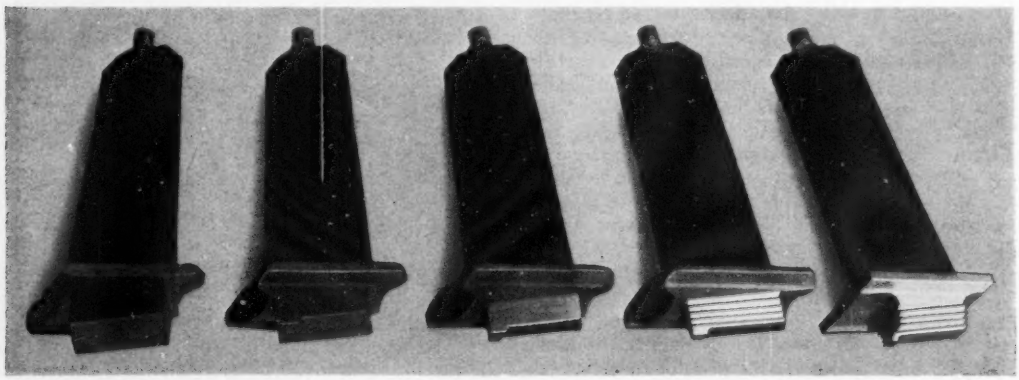


Fig. 10. Examples of stainless steel compressor rotor blades on which fir-tree root serrations are broached, showing the work performed at the successive operations. A finished root is seen at the right

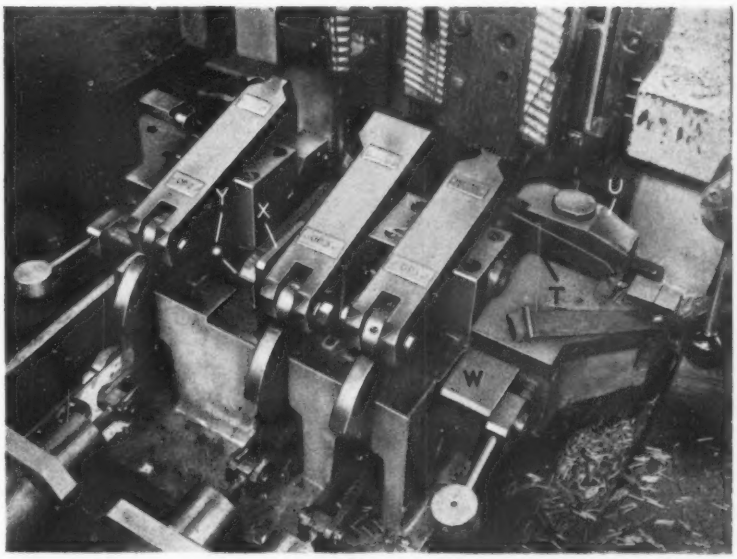


Fig. 11. In this close-up view of the fixture on the machine in Fig. 9, the arrangements for holding the blade at the three different fixture positions are clearly shown

it rests on the leading edge of the aerofoil portion, from which a light cut was taken during the preliminary milling operations already mentioned. In this position, the nearer long edge of the root is adjacent to a vertical surface and the cylindrical pip at the end of the aerofoil is level with a V-groove in the main body of the fixture. On the far side of the blade there is a horizontal bar *U*, with hardened inserts at each end. One of these inserts is flat, to engage a root surface, and the other has a V-groove for the aerofoil-locating pip.

This bar is connected to a horizontal plunger *W*, which passes through the fixture casting and has a locking cam attached to one face on the operator's side. When the locking cam is turned, by means of the attached lever, the plunger *W* is drawn towards the operator, and applies pressure to clamp the root end and the locating pip of the blade. End-wise location of the blade is obtained from the end face of the pip, which is thrust to the right, against a fixed surface, while the clamp is being tightened. Further pressure is then applied to the end face of the blade root, as the table moves towards the cutting position, by means of the main clamp, in the manner previously explained.

The broach which operates on the blade root at this first position is of plain flat form, and removes between 0·060 and 0·090 in. from the long face, on the concave aerofoil side of the blade. A similar amount of material is removed from the long face on the opposite side of the root at the next stage, for which the blade is transferred to the left-hand position of the fixture. Here, the blade is located and clamped in the same manner as before, except that it is turned round to present the opposite face of the root to the broach teeth. Broaching of the end face of the root, to produce the angular step seen in the second example from the left in Fig. 10, is subsequently performed at the central position of the fixture.

At this position, the blade is loaded with the concave side downwards and rests, at the required angle, on the previously-broached face. The locating pip is positioned in a V-groove, and secured by means of a lever-type clamp *X*, operated by a cam on a spindle which is turned by means of the small ball-ended lever *Y*. The next machine also provides for three separate broaching operations and a view of the set-up is given in Fig. 12. At the first stage on this machine, the sides of the root are broached to the approximate angle required on the completed blade, usually between 36 and 40 deg. inclusive, as seen on the example at the centre in Fig. 10. For this operation, the blade is loaded in the separate left-hand fixture, with the convex side of the aerofoil facing outwards, and resting on one end face of the root, with the pip in a V-location.

Clamping is effected by a horizontal bar, to which pressure is applied at a point near the centre by means of a capstan nut, the arrangement being similar to that at the side of the right-hand fixture. The bar exerts pressure on one long side of the root platform, and has a V-groove to engage and grip the pip at the other end of the blade. Pressure is finally applied to the top face at the root end by means of the main clamp, which is fitted with a cam in place of the roller employed at the previous set-up. The pressure pad with which this cam makes contact, when it is turned

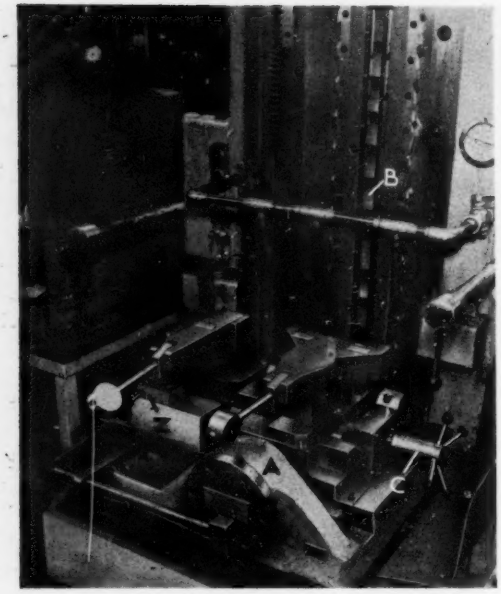


Fig. 12. The left-hand fixture on this machine holds the blade while the root is broached at the fir-tree angle, and the right-hand fixture is employed for copy-broaching of curved platform faces

to tighten the clamp, is carried on a swivelling block *Z*, and the latter can be swung aside when the work is unclamped to facilitate loading and unloading.

BROACHING OF CURVED SURFACES

On certain blades, including those shown in Fig. 10, the under-sides of the root platforms require to be machined to a radius which may vary between 22 and 34 in., depending on the size of blade. This operation is performed, on each side of the blade root in succession, at the two remaining fixture positions in Fig. 12. These two positions are incorporated in a single fixture, which is provided with square-section ways and can move towards and away from the broaching slide independently of the table, which is advanced to its fixed cutting position by the standard mechanism, comprising a transverse hydraulic cylinder and a rack and pinion in the machine base.

To provide for broaching the curved surfaces required, the table casting is made with a housing *A*, for a hydraulic cylinder, the ram of which is connected to the fixture. On the face of the fixture, adjacent to the broaching slide there is a roller, mounted on needle bearings, and in a central position between the two rows of broach teeth there is the cam bar *B*, the face of which is machined with a series of arcuate portions of the curvature required on the under-side of the blade platforms. Hydraulic pressure of about 100 lb. per sq. in. is applied to the cylinder, which has an effective diameter of approximately 6 in., and the roller is thrust against the bar with a total force of some 2,800 lb. This force is quite sufficient to ensure that the roller is held in close contact with the bar against the pressure exerted by the broach teeth, and as the bar is carried down with the broach slide the fixture is caused to move towards and away from the cutting teeth. In this way, the required curved surfaces are produced.

For each of the arcs on the cam bar there is a broach tooth at each side, and each set of teeth operates on one side of a blade. Each tooth is of radiused form to provide the blending required between the side face of the root and the underside face of the platform, and there are 20 teeth which are spaced to suit the blade chord. A

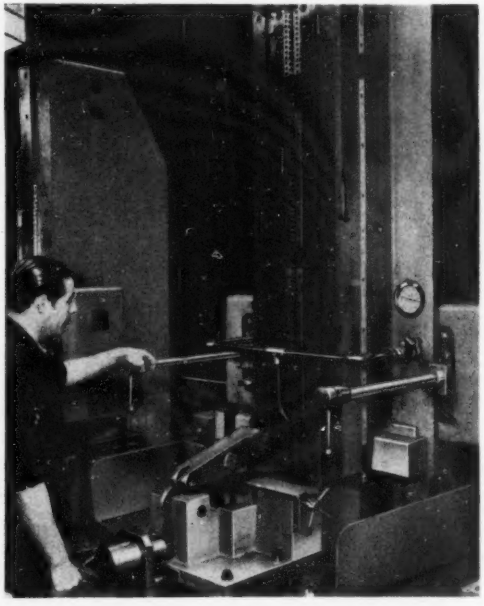


Fig. 13. Broaching of the fir-tree serrations is carried out on this single-position machine, on one blade at a time, to ensure that the form is produced to the required standards of accuracy

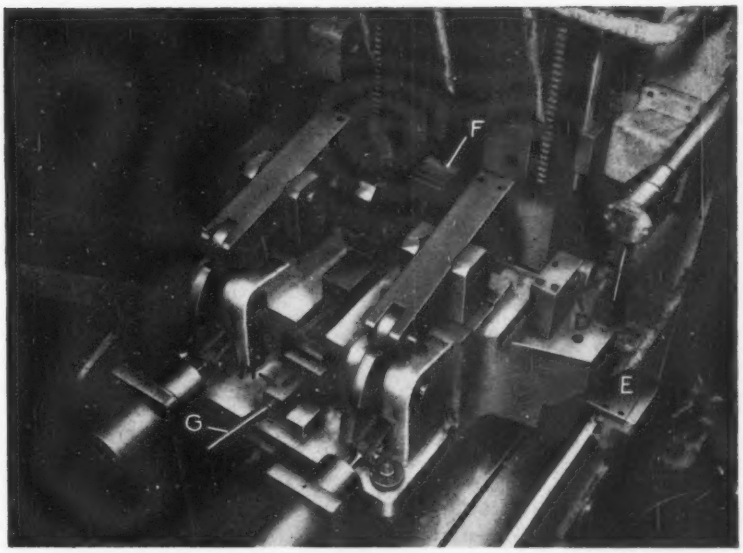


Fig. 14. At the central station of this 3-position fixture, the long sides of the platform faces are finished with the blade root held in serrated jaws in the box-shaped clamping unit *F*, clearance for which is provided by a deep groove in the broach slide

felt pad above the roller is held in contact with the cam bar *B* to wipe away any swarf which might fall between the two and cause an error in the generated surfaces. The blades are loaded in the same manner as in the left-hand fixture, and the side-clamping bars are tightened simultaneously by means of the capstan nut *C*. Both the second and third positions are loaded with workpieces before the machine is operated.

From the left-hand fixture on this machine the blade is transferred to the central position, where it is loaded with the convex side of the aerofoil to the left. When the blade is transferred to the right-hand position, it is loaded the same way up, since the broach teeth cut on the inner faces of both blades.

Broaching of the fir tree serrations on the sides of the angular root faces is next carried out, as exemplified by the second blade from the right in Fig. 10, and the machine employed for this work is seen in Fig. 13. It will be appreciated that the limits imposed on the serrations are finer than those specified for the remainder of the root surfaces. For instance, the serrations must be accurate within 0·0003 in. for pitch and relative position on each side of the root, and other dimensions are held to total tolerances of 0·002 in.

Serration-broaching is therefore performed as a single operation on one machine and the fixture provides for clamping only one blade, which is held in a similar manner to that described in connection with the set-up in Fig. 12, except that the main clamp is tightened by the spring-loaded pull-bar method discussed earlier. Since high accuracy and a good surface finish must be obtained, it may be of interest to describe the broach employed in somewhat greater detail than was necessary for those incorporated in the previous set-ups. The broach is made up of segments, each about 10 in. long, for ease of production, and these segments are let into a grooved holder attached to the vertical slide. The first part of the broach comprises two of these segments, and contains a total of 34 pairs of teeth with grooves which are gradually deepened towards the top, whereby almost complete serrations, but of a slightly truncated form, are produced.

This leading portion of the broach is operated with a loading of approximately 0·003 in. per tooth, and it is followed by a semi-finishing portion near the centre of the slide. In this section there are 26 separate pairs of teeth, each held in place in the groove by an individual socket head screw. The loading on these teeth is 0·001 in. and they bring the serrations very close to the finished size. One pair of the semi-finishing teeth is ground to a shape which ensures that the bottoms of the serrations are cleaned out, and there are two such "digger teeth" in the final, finishing, portion of the broach. This final section has 12 pairs of teeth, again separate from each other, most of which remove a thickness of the order of 0·0002 in. from the surfaces on which they operate. Sharpening and setting of individual teeth can be performed with this arrangement, and considerable savings in broach costs are thus obtained.

It may be noted that each of the broaching machines in the lines is provided with its own overhead swinging hoist, supplied by George W. King, Ltd., for handling the heavy fixtures and broach-

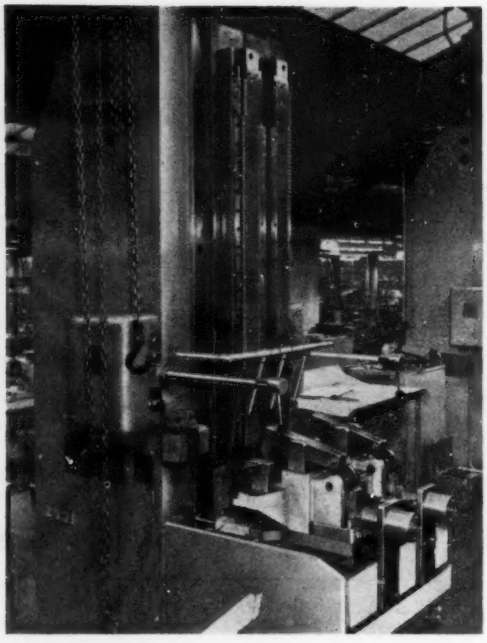


Fig. 15. This view of the machine in Fig. 14 shows the positions of the various sets of broaching teeth employed for finishing operations on the root ends adjacent to the leading and trailing edges of the aerofoil portion of the blade

holders employed. From the serration-broaching machine, the blades are passed to the main machine shop, where the end surfaces of the root platforms are rough-milled at the required angles. The blades are then returned to the broaching department for the final operations on the end surfaces of the roots, whereby they are brought to the condition shown at the extreme right in Fig. 10. A close-up view of the fixture employed for these final operations is given in Fig. 14, and it may be observed that there are, again, three different broaching positions. The blade is first loaded at the right-hand position where it is held at an angle such that the end surfaces of the root are vertical, and with the convex side of the aerofoil upwards.

A lever-operated cam, hidden by the main clamp, is employed to push the blade to the right until the end of the pip is in contact with an end face in the fixture, and the pip is then clamped between V-faces by means of a rotary cam, which is turned by the lever *D*. When the table is moved forward to the broaching position, a roller at the right-hand side of the fixture rides off a cam *E*, on the side of the machine base. A spring-loaded vertical slide within the fixture is thus permitted to move into contact with the angular step on the lower end face of the root, and pushes the latter back into the fixture, with the root face opposite to that to be broached against a datum surface. Continued movement of the table then results in the application of the main clamp, through the spring-loaded lever.

At this position, work is performed on the end of the root at the right-hand side of the blade at the right in Fig. 10, adjacent to the leading edge of the blade aerofoil. A broach with five sections is employed for this end of the root, and of these sections, the first three operate on different portions of the outline. The fourth section finishes the complete form apart from the platform face, which is finished by the fifth section. Another view of the machine, in Fig. 15, shows the different broach sections, also the left-hand side of the fixture, to which the blades are next transferred.

Here the blade is located and clamped in a manner similar to that just described, except that the vertical slide is omitted, and the first section of the broach operates on the platform face at the trailing edge of the blade. Sections two, three and four then rough out the curved form seen in Fig. 10, and it is finished by the fifth section. Finally, the sixth section of the broach completes the machining of the platform face and the small tang at the extreme end of the root. The central position of the fixture is employed for finish broaching the sides of the platform to an included angle between 5 and 7 deg., according to the size of the blade and the diameter of the rotor disc into which it is to be fitted. Here the blade is loaded with the aerofoil-locating pip in a V-location, and with the root serrations engaged between two jaws in a box-shaped unit *F*, Fig. 14, which projects from the face of the fixture.

These two jaws are machined on their inner faces to match the root serrations and they are brought together to grip the root by means of the lever *G*. This lever is connected to the jaws by link bars and a bell crank, a horizontal bar being drawn towards the operator's side of the fixture, by the action of the forked cam *H*, when the lever *G* is pressed down. When the table is in the broaching position, the box-shaped unit *F* is held directly beneath a large square-section groove in the broach-holder which provides clearance for the holder to descend, the cutting teeth being disposed on either side of this groove. This stage completes the broaching of the root, and the blades then go to the machine shop for aerofoil machining and various finishing operations.

Indenting Equipment and Applications*

By ARNOLD THROP, M.I.Mech.E.†

Since the second world war, efforts have necessarily been made to use available labour more effectively, and there has been a change from slow methods such as etching to indenting, hand machines have been replaced by powered machines, and attention has been directed to fully automatic machines and the incorporation of indenting or embossing with other processes, especially on sheet-metal press-work.

Experimental work has provided information on the loads required for indenting various metals with characters of different sizes and with deep and shallow impressions, and has made the selection of machines for particular tasks much more simple. Some typical charts giving the loads needed on certain metals are shown in Fig. 1.

In one factory, a 75-ton hydraulic press has been installed for indenting large inscriptions on the shanks of single-point carbide-tipped cutting tools. This factory produces only special tools, standard shapes being made at another works, and the average batch quantity is less than four. Sixty hours a week were required for hand-stamping, and this time was reduced with the machine to one-third, in spite of the fact that a completely fresh

* Abstract of a paper presented at the Conference on Technology of Manufacture held earlier this year by the Institution of Mechanical Engineers.

† Director of engineering, Edward Pryor & Son, Ltd. Sheffield.

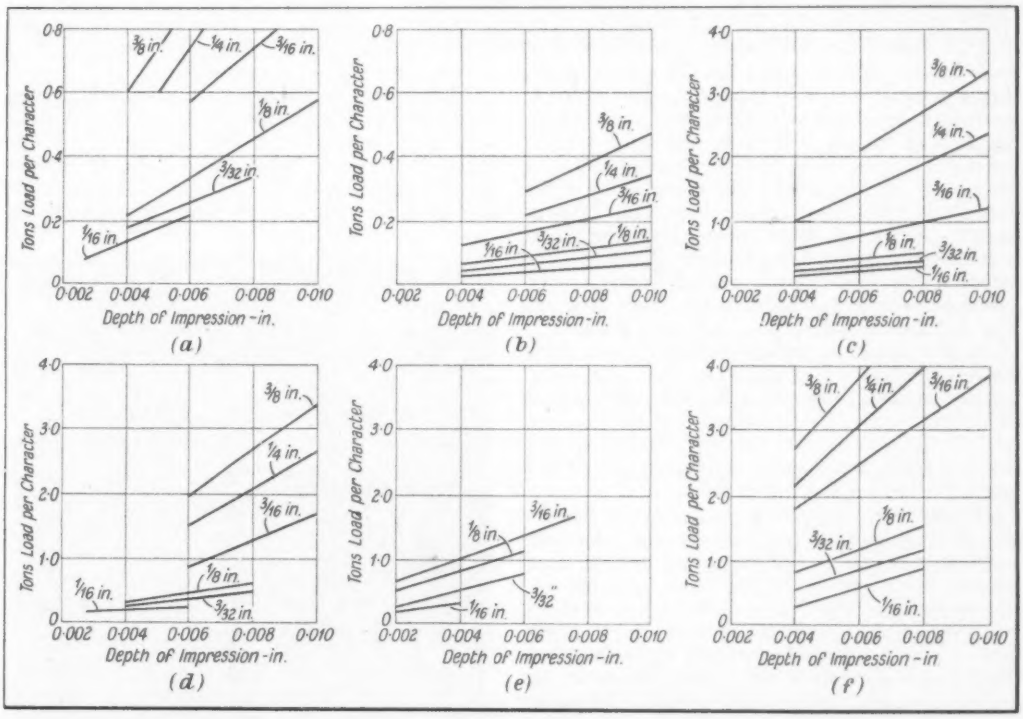


Fig. 1. Charts showing relationships of loads and depths of impression for different metals. *a*—hard rolled brass, V.P.N.96. *b*—soft aluminium, V.P.N.42. *c*—bright mild steel, V.P.N.194. *d*—18/8 stainless steel, V.P.N.173. *e*—titanium 317, V.P.N.290. *f*—S11 steel, V.P.N.422 (91-ton)

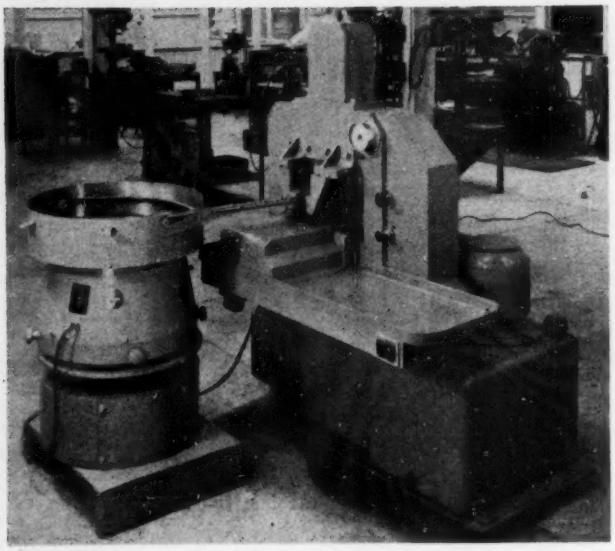


Fig. 2. Hydraulic press, equipped with a vibratory feeder, for automatically indenting ball bearing rings

combination of dies was necessary at the end of each batch. At the same time, the quality of the impressions was much improved. An identical machine is employed at another factory for indenting milling cutters. Even on the small batches involved, the new method is very much faster than that previously employed and the readability of the inscriptions has been greatly improved. On a similar machine of twice the capacity, the sheet-steel cover of a calculating machine is indented for about 5 per cent. of the cost of engraving the characters required, which number about 200, and the steel has replaced more costly brass sheet.

In the Sheffield cutlery industry some table knives are now being made for the more competitive markets from cold-rolled steel strip instead of forgings. The greater precision of the resulting parts simplifies loading and support, and many girls are indenting these blades on manually-operated machines at speeds of 1,800 per hour.

Requests are constantly being made by the engineering industry for semi-automatic or fully automatic machines, and are being met to some extent, but there is not sufficient capacity for design and development to enable these machines to be provided as promptly as would be desirable. Fig. 2 shows a new high-speed hydraulic press fitted with a vibratory feeder for the fully automatic indenting of certain sizes and types of ball-bearing rings. This machine can exert loads ranging from 20 tons down to less than 10 cwt. and, in its standard form, has three readily changeable speeds of 1,000, 1,500, and 2,000 pieces per hour. Where the parts are of such a form that completely automatic feeding would be difficult, the press can be hand fed by way of a magazine, in which the parts are placed by the operator. After they have been indented, the components are ejected automatically. The press can be employed for a wide range of components other than bearing rings.

On the semi-automatic machine shown in Fig. 3, engine valves are hand-loaded into a rotating carrier, whereby they are conveyed to the die which indents the stem with the part number, and are subsequently ejected automatically. With this machine an output of 40 per min. can be maintained.

Although many machines are independent units to which parts are brought to be indented, there is a growing tendency to install machines in production lines to reduce transportation, and the amount of work in progress. Fig. 4 shows a machine for indenting part numbers on tubes with thin walls, made from cold-rolled mild steel strip. After being cut to length by a flying-saw, the tubes roll to the marking machine, are picked up automatic-

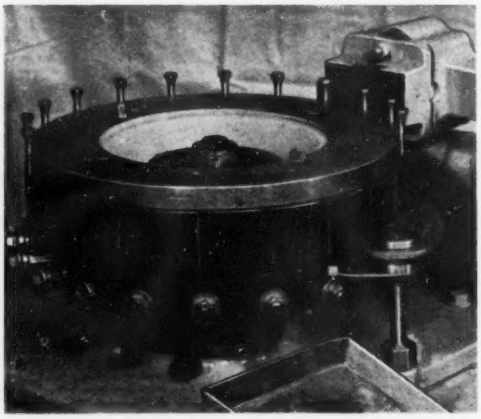


Fig. 3. Semi-automatic machine for indenting engine valve stems

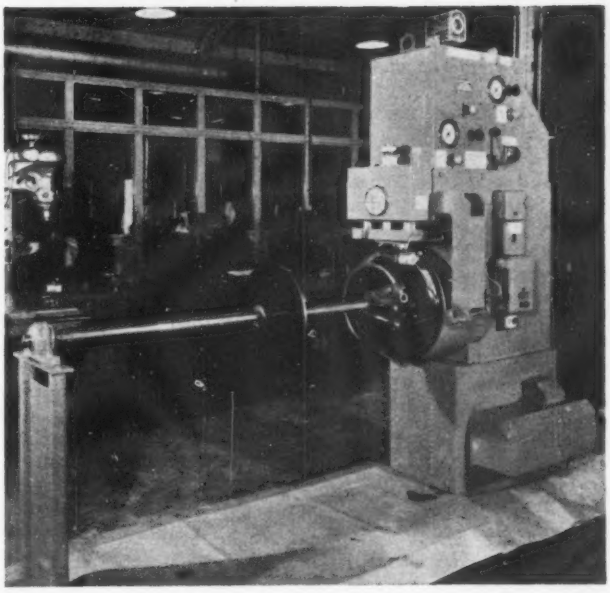


Fig. 4. Machine for automatically indenting part numbers on thin-walled steel tubes

ally, plugged to prevent collapse, indented and discharged, all without an operator. The machine incorporates a hydraulic drive to provide for speed control, and devices for stopping it in the event of a defective tube being presented, and signalling the stoppage visually and audibly.

Copper tubing for domestic water supplies and similar purposes is now required to be marked to show the identity of the maker. In order to permit such tubing to be used with capillary solder ring fittings the burrs raised must be very small indeed, and are, in fact, maintained at about 0·0005 in., although the impressions are perfectly readable. Several machines have recently been made for this work. The tube is passed between two grooved rollers, one of which has an inserted and replaceable indenting die, at a speed of 450 ft. per min.

The graduating of machine tool elements, including cylindrical micrometer dials and straight parts such as drilling machine depth-stops, is carried out on an increasing scale, and most of the firms in the British machine tool industry are using indenting methods with significant reduction in component costs. As an example, many thousands of depth-stops, graduated and numbered over a length of 4 in. by sixteenths on one side, and over a corresponding length in millimetres on the other, have been produced in one set of dies at a cost of less than sixpence each. Similarly, dial rings of 7 in. diameter, with 400 lines and the appropriate numbers, are handled at the rate of 50 pieces per hour. Cast-iron compound-slides for lathes, which are too weak to withstand heavy pressures, have been successfully roll-indented, and Fig. 5 shows a die used for this purpose.

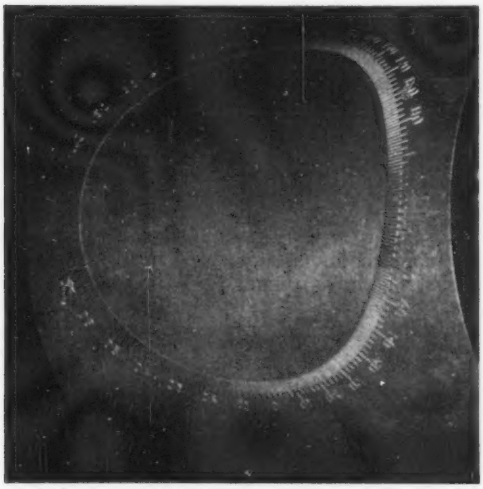


Fig. 5. Roller die for indenting graduations on cast iron compound slides for lathes

NOTCH EFFECTS ON INDENTED PARTS

Some anxiety has been expressed from time to time, especially in the aircraft industry, about the danger of heat treatment or fatigue failures where part numbers, for example, are indented. Some of these fears have arisen because crude uneven-depth hand-stamping has been taken as the standard, and when proper machine marking, under well-controlled conditions, has been substituted, the fears have proved groundless. It cannot be denied, of course, that any kind of notch may be a potential source of a fatigue crack, and is therefore to be avoided in a highly-stressed zone of any component, but caution could well be

tempered with realism. Most highly stressed components have one or more surfaces on which the stress is low. The end surfaces of a cylindrical shaft provide an example. Moreover, there are different kinds of notches. The majority of indenting dies are made with sharp cutting-edges bounded by bevels of between 80 and 110 deg. It is, however, practicable, although rather more costly, to produce dies with rounded cutting-edges, and one important aircraft company has been using such dies for the last four years. The largest manufacturers of aircraft gas turbines have now satisfied themselves that when used with the proper types of machines such dies may be safely applied for indenting gas-turbine blades, and have adopted them as standard for this work.

DIE DESIGN AND PRODUCTION

In general, die design has changed very little, although the degree of complexity has increased and dimensional accuracy is specified. The construction of dies from tungsten carbide may be regarded as a change, and such dies are now in current production on a commercial basis. Like carbide cutting tools, they are not the answer to every problem in their field. Apart from the question of cost, they cannot be used for all the operations that can be carried out with steel dies. It can be said that the use of carbide dies is justified in the following conditions:

(1) Where the indented material is hot and the period of contact is sufficient to cause softening of a steel die.

(2) Where most, or even occasional, components, are sufficiently hard to damage a steel die.

(3) Where components carry a hard abrasive scale which would cause rapid wear of a steel die.

(4) Where the quantity of parts to be marked is very large, and the conditions of load, transverse thrust, etc., are not unfavourable to the special physical properties of the carbide die.

The 3-dimensional pantograph engraving machine has continued to gain ground as against the old hand-cutting process for producing relief characters on dies. Cold-swaging methods for single-character pieces have been more widely adopted, and are assisting in keeping prices down. They cannot, however, be applied to small-lot special dies of large area with complicated inscriptions.

Most indenting and embossing dies are made from a carbon alloy oil-hardening tool steel. Perhaps one of the more significant developments in manufacturing techniques has been the change from oil quenching to martempering. By this process, in which the part is quenched from about 800 deg. C. in salt at about 200 deg. C., completely satisfactory hardness is obtained (65 Rockwell C scale), with absence of scaling from atmopheric oxygen. The distortion of the work is reduced, risk of cracking is minimized, and a very clean surface is maintained.

There has been some thought as to whether either of two new processes now in use for toolmaking might be applied to the forming of relief characters on indenting and embossing dies. The author has not yet seen a die made by either of these methods, namely, spark erosion or ultrasonic abrasion, which compared for quality with an ordinary commercial die from the pantograph engraving machine. Moreover, although the equipment for each of these processes will operate with a minimum of attendance, it is costly and must bear a high hourly charge. Although these processes are undoubtedly proving very successful, in certain fields, it would appear that some time is likely to elapse before they can compete on a cost basis with the pantograph engraving method, for the production of indenting dies.

For many years, the author has been advocating the simplification of indenting die blanks, to enable the loss of productive performance due to reheat-treatment, and the nuisance of organizing re-cutting to be avoided without undue cost in "throw-away" parts. Since 1945 that policy has appealed more and more to large users of dies, and the possibilities of reconditioning by the two processes mentioned are of less advantage where "throw-away" inserts are being used.

The author acknowledges his indebtedness to the directors of Edward Pryor and Son, Ltd., for permission to present the above information, also to many colleagues for their joint contributions to improvements in techniques.

KENWELL ANTI-VIBRATOR UNITS FOR LIGHT FITTINGS.—The working life of an electric lamp or fluorescent tube is increased if it is isolated from vibration, and Kenwell Electric, Ltd., Meanwood Works, Spotland Bridge, Rochdale, Lancs., have developed a range of units which can be installed between light fittings and the suspension conduits or chains to allow them to "float." Known as Anti-vibrators, the units are made in three types, for light, heavy, and extra-heavy fittings. Nominally cylindrical in shape, each unit has an opening at the top to receive the conduit or chain suspension, and a shank at the bottom with ¾-in. electrical thread to take the lamp fitting. The weight of the fitting is carried by a compression spring, and the unit includes a built-in flexible earth connection.

Roto-Finish Chip Separating Equipment

Equipment supplied by Roto-Finish, Ltd., Mark Road, Hemel Hempstead, Herts., for handling barrel-finishing media and components includes the mechanical separator shown in Fig. 1. This unit incorporates a container within which there is a frame carrying the wire mesh screen, and provision is made for fitting screens of different mesh sizes to suit the work to be separated. The frame is supported on six helical springs attached to the container, and the latter unit is mounted on the main structure by means of rubber bushes. Vibration of the frame and screen, at a fixed amplitude, is provided by a Trillor electric vibrator which is controlled by a push-button starter. Normally, the rate of flow of the material across the screen is varied by altering the angle of the slope, and for this purpose the front legs of the unit are adjustable. They can be set to one of three heights, and locked by retaining pins.

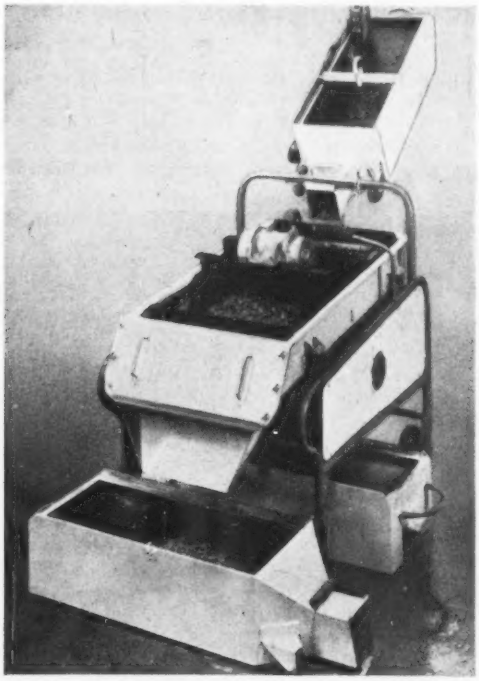


Fig. 1. This Roto-Finish mechanical separator incorporates a wire mesh screen, which is vibrated at a constant amplitude by an electrical unit

Fig. 2. For the separation of ferrous components from barrel-finishing media, this magnetic drum type unit may be employed. It is made in two sizes, of which the smaller is here shown

A magnetic separator is made in two sizes, of which the smaller is illustrated in Fig. 2. This machine is of the under-feed drum type and a hopper is built into the framework. The bottom of this hopper is so mounted that it can be vibrated by means of cams operating in conjunction with return springs, and a control gate is fitted which enables the work-load to be delivered evenly to the lower side of the magnetic drum. Made from non-magnetic material, the drum, which is either 6 or 12 in. wide, is driven through belt and chain from the ¼-h.p. cam-driving motor, and contains a fixed permanent magnet to pick up the components as they pass. Chips and other non-magnetic materials which are not picked up by the

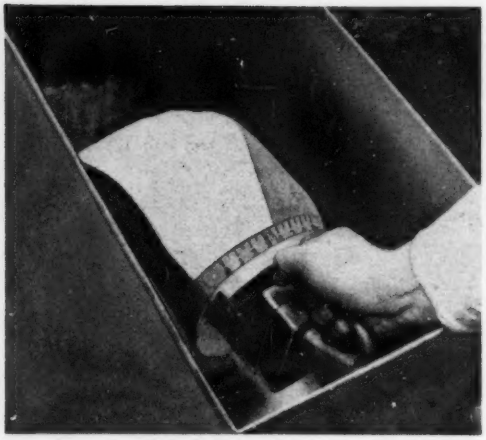


Fig. 3. Measurement of quantities of finishing compound is considerably facilitated by the use of this weighing scoop, which has a capacity up to 7 lb., and is graduated in ½-lb. divisions

drum pass down a chute into a container. Parts which are retained by the magnetic field of the drum are carried round to a position at which the field is insufficiently strong to hold them, and they then fall down another chute into a separate container.

The heights of the units are so arranged that standard Roto-Finish containers and hoist pans can be employed for collecting the chips and components. A weighing scoop, shown in use in Fig. 3, facilitates measurement of abrasive and other compounds. It has a capacity up to 7 lb., in ½-lb. divisions. When using such a scoop, compounds can be taken directly from the storage containers and transferred to the barrel or charging apparatus without the need for intermediate weighing.

Erie 2,500-ton Transfer Forging Press

Claimed to be the first of its type, the 2,500-ton transfer forging press shown in Fig. 1, has been developed by the Erie Foundry Co., Erie, Pa., U.S.A., for the production of components such as connecting rods, gear blanks, motor-car valves, track links, and wheel hubs, on a fully automatic cycle.

Fig. 2 gives a close-up view of the press set up for the forging of track links for caterpillar-type tractors, and part of the transfer mechanism may be seen. Measuring about 10 by 4 in., as viewed in plan, the track links are produced in two stages from heated blanks, of 1⅝ by 1⅝ in. cross-section by 8½ in. long, which are delivered by a conveyor from a furnace at the left-hand side of the press, through an opening in the frame. A pusher mechanism then positions the blank between the first of three pairs of gripper jaws, which are attached to the transfer slides at the front and rear of the dies.

During the return stroke of the press, knock-out pins, operated by a cam on the crankshaft, raise the partly-formed component and the completed part clear of the forging dies, and the gripper jaws are then moved inwards to hold the workpieces and the blank. Next, the transfer slides are moved to the right, and the gripper jaws are opened. In this manner, the blank is loaded on to the first forging die, and the partly-formed piece is transferred to the second die in readiness for the finish forging operation. At the same time, the completed workpiece is passed through an opening in the right-hand side of the frame, and is discharged into a container by way of an inclined chute. When this sequence has been completed, the transfer

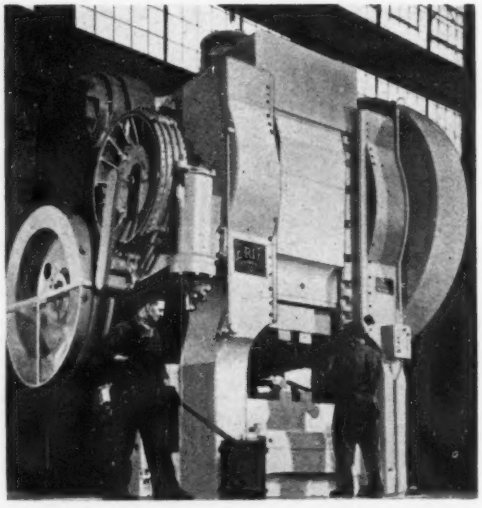


Fig. 1. Erie 2,500-ton fully-automatic transfer forging press

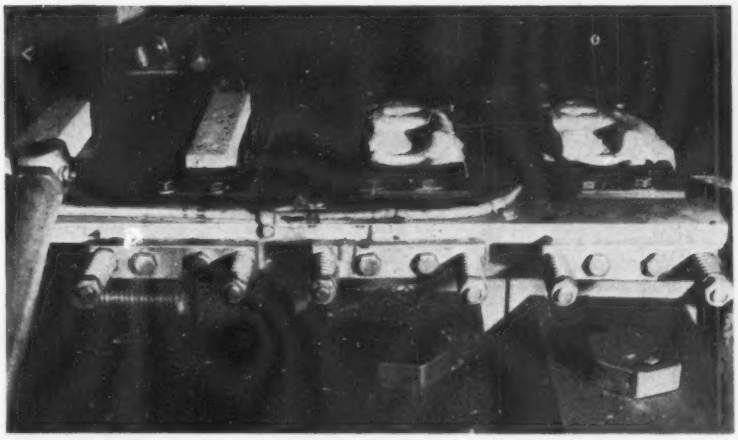


Fig. 2. Close-up view of the Erie forging press, showing part of the transfer mechanism

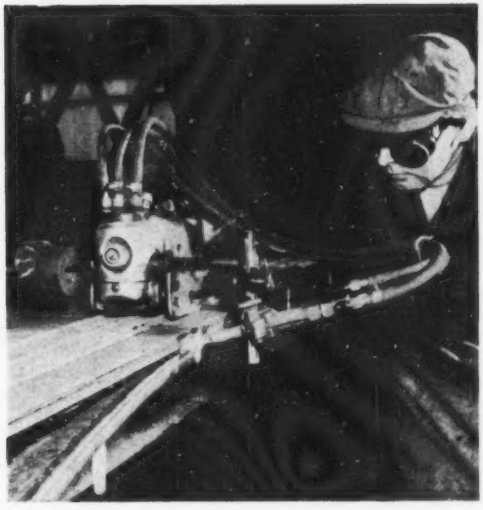
slides are returned to their left-hand position, and, simultaneously, the ram descends.

The press, which runs continuously, has an operating speed of 40 strokes per min., and enables a component to be produced at each working cycle. To prevent over-heating of the dies, however, blanks are delivered to the first pair of gripper jaws only at alternate cycles. Consequently, forgings are produced at the rate of 1,200 per hour. If required, three or four forging dies, or two forging dies and one or two trimming dies, can be employed on the press, additional gripper jaws then being fitted for handling the workpieces. Drive to the transfer mechanism is transmitted by a chain from the crankshaft, and thence through a system of levers positioned clear of the die area. With this arrangement, free access is afforded for die changing or adjustment.

Drive to the crankshaft is transmitted by an air-operated 2-plate clutch housed in the main reduction gear, and the band-type brake has hinged cast steel shoes with bolted-on linings, and can be reversed when worn. The press has an overall height of 11 ft. 3 in.

Burton Griffiths & Co., Ltd., Mackadown Lane, Kitts Green, Birmingham, 33, are the agents in this country for the Erie Foundry Co.

Chamfering Steel Plates



Chamfering plates with a Bantam flame-cutter

The accompanying figure shows a Bantam flame-cutting machine (British Oxygen Gases, Ltd.), which has been modified to produce shallow chamfers on the edges of the tank top bed plates which support the engines in a ship. These chamfers, which were previously produced either by a planer or by hand cutting and grinding, are required for a subsequent butt-welding operation.

In use at the West Hartlepool dockyard of William Gray & Co., Ltd., the Bantam machine has been fitted with an extra rack and pinion adjustment, and the counterweights seen at the left are employed to balance this additional weight. The plates to be chamfered measure 10 ft. 6 in. by 4 ft. by 1¾ in. thick, and the cut, which is 4 in. wide and at an angle of approximately 11 deg., is taken at a rate of 6 in. per min.

High-output Machining Set-ups for Cylinder Lock Components

By F. J. GIANNITTI*

Efficient production of small parts—principally die castings of zinc alloy—is the chief concern at the plant of the Yale Lock and Hardware Division of the Yale & Towne Manufacturing Co., Salem, Va., U.S.A. The die castings are produced within the plant, often by means of multiple-cavity dies, and a considerable number of the parts have such irregular shapes that they would be difficult to make by any other means. Although the castings are held within close dimensional tolerances, flash must be removed from all components, and many need some additional machining.

Simple equipment is used for such machining operations, but the work is often expedited by unusual tooling. The larger of the cylinder-lock parts shown in Fig. 1 is die cast with the main parting plane at the flanged end. Flash surrounding this end is sheared off in a trimming die in the usual manner. The five small, closely-spaced cross-holes (for the tumblers) are produced by cores which are withdrawn transversely. In addition to carrying the tumbler-hole cores, the core slide is shaped to form the rectangular recess in which the holes are located, also to produce the surrounding rib. Flash is produced at the intersection of the tumbler holes with the cylinder bore, and around the rectangular rib.

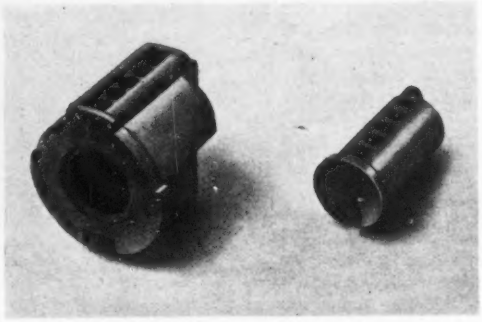


Fig. 1. The lock cylinder at the left is die cast in zinc alloy, with the bore and transverse tumbler-holes produced by cores. The brass plug (right), that fits the cylinder, has a broached key slot

A special air-operated tool is used to remove flash at these positions, also to true the five tumbler-holes. This tool has five broaches which shave the holes, also two straight cutting edges

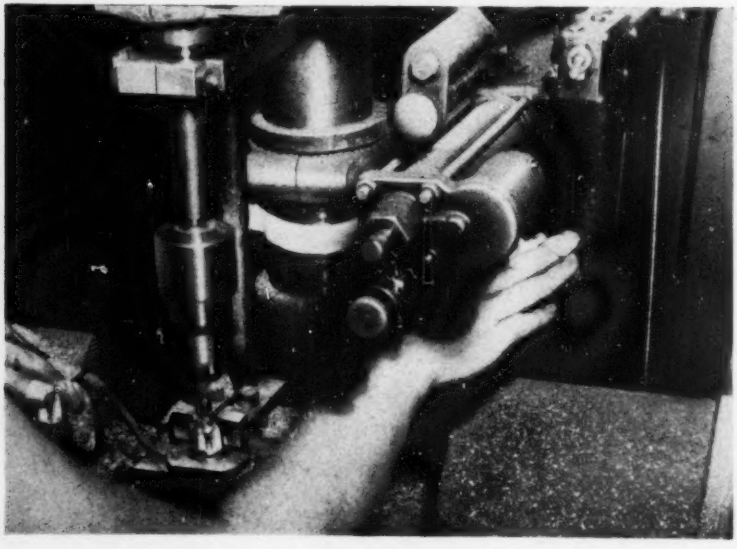


Fig. 2. At this set-up, the bore in the die-cast cylinder, shown at the left in Fig. 1, is reamed and one end is spot-faced to maintain a close-tolerance axial dimension

* Tool Engineer, Yale Lock & Hardware Division, Yale & Towne Mfg. Co., U.S.A.

that shear the flash from the two long sides of the rectangular rib. This operation is carried out with the part supported in a nest which positions the workpiece accurately in relation to the tool, after it has been loaded by hand. Broaching is performed at the rate of 1,350 pieces per hour.

After the broaching operation, the lock cylinders are dropped on to a belt conveyor whereby they are carried to a light-duty Delta drill press. This machine is shown in Fig. 2, and the spindle carrying the cutting tool is advanced by a Bellows air-operated feed unit. Two operations are performed at this set-up. Firstly, the cylinder bore is reamed to correct the taper formed by the draft on the core-pin, and to remove any burrs that have been thrown into the bore by the broaching of the five tumbler-holes. Secondly, a small amount of metal is machined from the stepped end of the casting by a spot-facing cutter that is mounted on the tool shank above the reaming teeth.

The distance from this spot-faced surface to the face of the stepped recess in the lower end of the main bore is held to 0·803/0·805 in. To maintain this tolerance, the casting is located endwise by a boss on the supporting fixture and this boss is engaged by the shoulder face of the recess. A sliding member on the fixture acts as a stripper and prevents the component being lifted with the reamer as the latter is retracted. The stripper slide is advanced by a tapered bar which is mounted at the rear of, and is moved down with, the cutting tool. The stripper is withdrawn before the next piece is loaded into the fixture. This duplex operation, which completes the machining of the casting, is carried out at approximately the same rate as the broaching stage.

Fig. 3. Five blind tumbler holes, cored in die cast deck lock plugs, are drilled through in rapid succession while the piece is clamped in a sliding V-block below a spring-loaded jig plate

In another die casting, known as a deck lock plug, there are five blind, cored tumbler holes which are drilled through, one at a time, in a light-duty Delta drill press. The set-up is shown in Fig. 3, and the workpiece is loaded in a V-block which is free to slide under a spring-loaded jig plate.

This jig plate moves on vertical guide pins, and is raised by hand to permit loading. The plate serves to locate the workpiece endwise, and

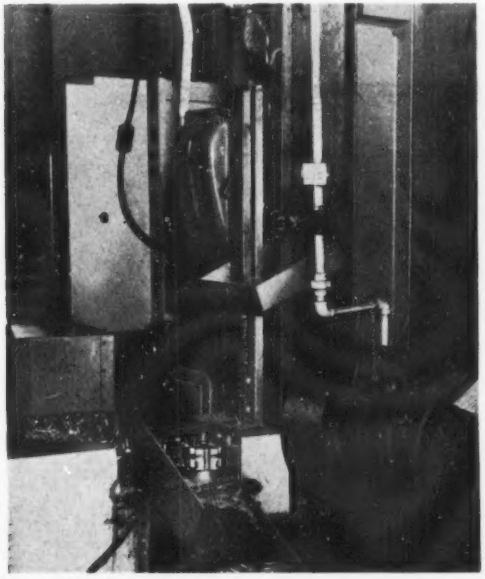


Fig. 4. Key slots, of wavy cross section, are cut in brass plugs for cylinder locks on this special automatic broaching machine. The broaches are mounted in a counterbalanced rack which is traversed up and down by a pinion drive

has five holes which are spaced to correspond with those cored in the casting.

When the jig-plate has been lowered to clamp the workpiece in the V-block, the plate, workpiece and block move together as the block is traversed by the operator, using her left hand. With her right hand the operator actuates the sensitive feed-lever of the machine, each time a hole in the jig plate is aligned with the drill. The operator can readily align the plate with the cutting tool, to drill the five holes in each workpiece, and the drilling operation is performed on 800 parts per hour.

A slot must be machined in each cylinder-lock plug, parallel with its axis, to receive the key which must be inserted before the plug can be turned in the assembled lock. This slot is of a form to suit the sinuous cross-section of the key. If the plug is die cast, the slot is usually cored and does not have to be machined since the core, which is accurately formed to correspond to the key cross-section, produces a slot with smooth surfaces.

The specifications of certain locks call for a brass plug of the type seen at the right in Fig. 1. Blanks for such plugs are turned and cut off to length in an automatic screw machine. Due to its sinuous cross-section, the slot cannot be milled and it is produced by broaching in the special machine Fig. 4. The broaching tool is made in five sections, each 12 in. long, which are securely fastened to a rack. The rack, in turn, is mounted in vertical guide ways and is counterbalanced. A pinion engages the rack teeth and transmits the drive to traverse the tool upwards or downwards.

The workpiece is held in a special fixture mounted on the bed of the broaching machine. Formerly, a fixture to hold only one workpiece at a time was used, and had to be re-loaded after each return stroke of the broach. This fixture has now been re-placed by the dial-type indexing unit seen in Fig. 5. With its longitudinal axis positioned vertically, each workpiece is loaded by hand between gripper jaws, when they are well clear of the broaching position. As the part is indexed towards the broach from the loading station, the jaws automatically clamp the workpiece and hold it securely. The workpiece remains at the broaching position for about 10 sec. During subsequent indexing motions, the slotted plugs are unclamped and are released into a chute. Apart from hand loading of the fixture, the machine is completely automatic in operation and an average output of approximately 355 plugs per hour is maintained, although 400 plugs per hour can be broached.

Although keys for cylinder locks could be die cast, stamped blanks can be produced more quickly and are stronger. The grooves in the blanks must be milled after the stamping operation and milling is carried out at a rate of about one blank per sec. in automatic machines. One of the new Davis-Thompson key slot milling machines which have been built to Yale and Towne specifications is shown in Fig. 6. Key blanks are loaded by hand into a magazine and one blank at a time is "wiped" from the bottom of the stack as a recess in a reciprocating slide passes below the magazine unit. When the workpiece has been carried by the slide to the milling position, rotating cutters, set one

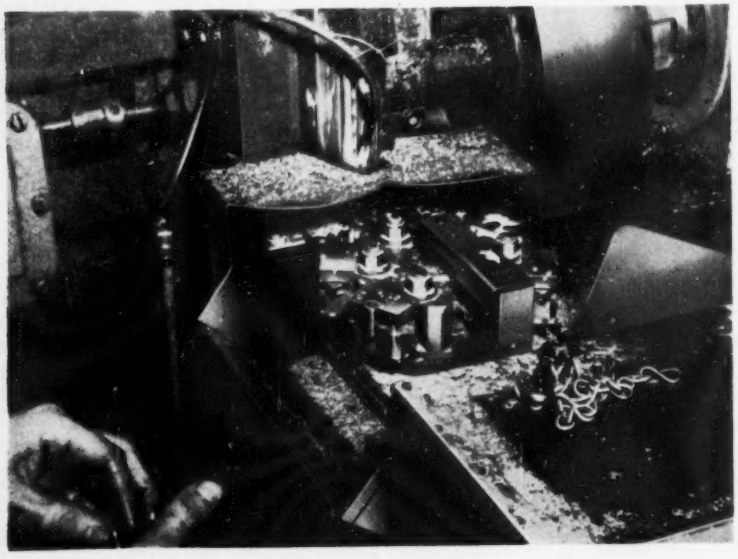


Fig. 5. Close-up view of the indexing fixture for the broaching machine (Fig. 4). Lock plugs are loaded by hand and are clamped and released automatically. After broaching, the parts are delivered by chute into a work pan

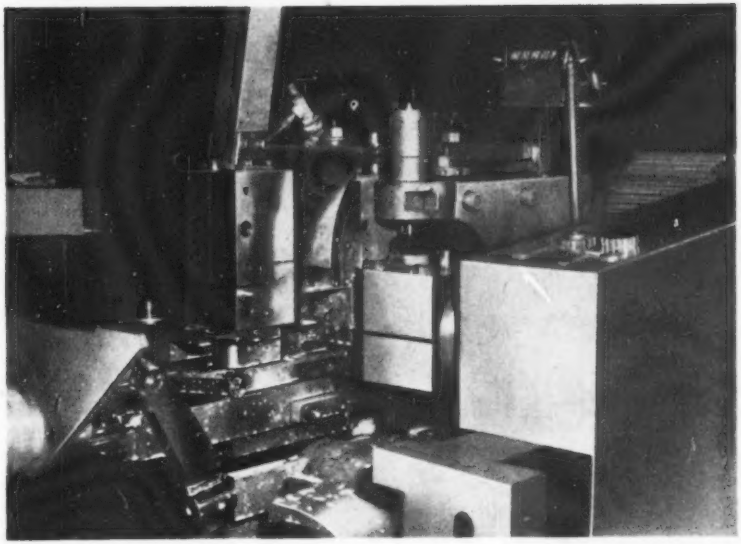


Fig. 6. This machine provides for milling three longitudinal slots in key blanks. Workpieces are advanced automatically from a hand-loaded magazine and an average output of one key per sec. is maintained

above and one below the blank, are advanced automatically by cams, and make plunging cuts into the blank to the required depth.

Next, the slide is retracted so that the key is moved longitudinally relative to the two form cutters, which complete 3 slots, one near each edge in the top face of the blank, and one in the centre in the lower face of the blank. At the end of this milling pass, the key drops out of the recess and the slide returns to the loading position. This machine is operated at 50 to 72 cycles per min., and 1½-in. diameter, high speed steel cutters with 16 teeth are employed and are run at 2,350 r.p.m. The teeth on the top cutters have no rake angle and the cutters can be set to suit the spacing of the particular type of key that is being machined. A copious flow of coolant is applied to wash away the chips produced.

After milling, the keys are passed through embossing dies and are stacked in sets in readiness for gang notching to suit the different types of key designs that are required. The notches are produced in each set of keys by cross-milling.

Resistance Casting

A discovery in resistance welding, which has been provisionally patented, is now being developed by the British Welding Research Association at Abington, near Cambridge. The discovery evolved directly from work carried out on behalf of the United Kingdom Atomic Energy Authority.

In spot welding, molten metal is expelled if the welding current is too high or if the electrode force is too low. This molten metal can be directed into a cavity in the welding face of an otherwise normal spot welding electrode. Since it freezes there to form a stud, strongly welded to the parent sheet, the technique is known as resistance casting, or sometimes as stud raising, or pimple welding.

Studs of highly varied shapes and sizes have been formed by this process in a wide range of metals, including steel, stainless steel, light alloys, titanium, and nickel alloys. A peg of similar or different material, inserted in the electrode cavity, can be cast into the stud. Strong metallic bonding between the peg and stud can occur with compatible metals, and the purely mechanical joint which is formed with non-metallic pegs may also be strong.

If each electrode is provided with a cavity, projections will be formed on both sides of the article. Since the metal for the stud is drawn from the molten spot weld nugget it is generally necessary to have at least two sheets of metal between the spot welding electrodes to enable a stud to be raised.

It is proposed to undertake a survey of possible industrial applications for the new process, but some are already obvious. Amongst the less obvious, are the raising of projections on tubes or flat surfaces to form heat exchangers. Projections suitable for projection welding can be made by resistance casting on material whose thickness is so great as to prohibit it being raised by a pressing operation.

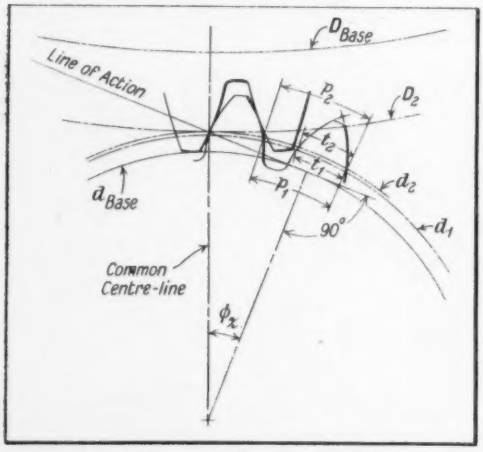
Gear Calculations Simplified by the Use of Williamson Tables

By C. A. UNDERWOOD*

Calculations for the sizes of involute gear-tooth elements for gears which depart from basic or original specifications is usually lengthy and tedious. Such calculations, however, can be simplified by the use of tables recently compiled by Mr. J. L. Williamson of the Fellows Gear Shaper Co., Springfield, Vt., U.S.A. These tables, to which attention was drawn in MACHINERY, 91/1445—20/12/55, avoid the need for any other tables and reduce the necessary numbers of steps in the calculations.

The Williamson tables are convenient for such purposes as obtaining the effective tooth thickness at various diameters, finding the centre distances for gears of known arc tooth thicknesses, estimating dimensions over or between precision gear measuring pins, and solving for a new centre distance (or ratio) where a change in the original centre distance (or ratio) is desired.

* Gear Consultant, Raytheon Mfg., Co., U.S.A.



The " line of action " of involute gears is a straight line tangent to the base circles, which crosses the common centre line at the pitch point. Basic tooth elements are indicated by symbols. Subscripts 1 and 2 indicate the original and new tooth-element dimensions, respectively

TABLE 1. LETTER SYMBOL DEFINITIONS

ϕ ϕ_1 ϕ_2	Pressure angle
t	Arc tooth thickness, pinion
T	Arc tooth thickness, gear
p	Circular pitch
P	Diametral pitch
r r_1 r_2	Pitch radii
d_1 d_2	Pitch diameters
d	Measuring pin diameter
n	Number of teeth, pinion
N	Number of teeth, gear
C	Centre distance
D_M	Pin dimension
I	Involute function difference
Δ	A change

Involute gears make contact on a locus which is a straight line tangent to the generating or base circles. When two gears are in mesh, the line tangent to their base circles crosses the common centre line and is termed the line of action, as indicated in the accompanying illustration. The distance to the crossing point (pitch point) measured from the centre of each gear is the pitch radius. If the distance between the centres of the gears changes, the angle of the line of action also changes, and new pitch point and pitch radii are established. The ratio of the second centre distance to the first is equal to the inverse ratio of the cosines of the angles of action. This ratio may be called the " cosine ratio," and when it is used in combination with the differences in involute functions of the respective angles, the calculation of gear element sizes and over-pin measurements is simplified.

The original Williamson tables list involute function differences and the corresponding cosine ratios for various base pressure angles. They were compiled as an aid in determining the centre distances to be employed between work gears and a known master gear when measuring the effective sizes of the former. The following examples illustrate some of the many additional applications of the tables. Portions of the Williamson tables pertaining to gears with 20- and 30 deg. base pressure angles are reproduced here in Table 2. As an added feature, the differences between tabulated values are listed for convenience when interpolating.

To minimize the use of subscripts in the equations, lower-case letters are used to indicate pinion elements and upper-case letters, gear elements. With a few exceptions, letter symbols

TABLE 2. INVOLUTE FUNCTION DIFFERENCE AND COSINE RATIO FOR GEARS WITH 20-DEG. AND 30-DEG. DESIGN PRESSURE ANGLES ϕ_1 AT VARIOUS ACTUAL PRESSURE ANGLES ϕ_2

Actual Pressure Angle ϕ_2, deg.	Involute Function Difference (I)	Tabular Difference	Cosine Ratio	Tabular Difference
For Gears with a 20-deg. Base Pressure Angle				
20	0		1·0	
		0·00023500		0·0006411
20·1	0·00023247		1·0006371	
		0·00023744		0·0006449
20·2	0·00046747		1·0012782	
		0·00024021		0·0006488
20·3	0·00070491		1·0019231	
		0·00024268		0·0006527
20·4	0·00094512		1·0025719	
		0·00024528		0·0006566
20·5	0·00118780		1·0032246	
		0·00024790		0·0006605
20·6	0·00143308		1·0038812	
		0·00025052		0·0006645
20·7	0·00168098		1·0045417	
		0·00025317		0·0006684
20·8	0·00193150		1·0052062	
		0·00025584		0·0006724
20·9	0·00218467		1·0058746	
		0·00025852		0·0006763
21	0·00244051		1·0065470	
		0·00026123		0·0006804
21·1	0·00269903		1·0072233	
		0·00026394		0·0006853
21·2	0·00296026		1·0079037	
		0·00026667		0·0006883
21·3	0·00322420		1·0085880	
		0·00026944		0·0006923
21·4	0·00349087		1·0092763	
		0·00027220		0·0006964
21·5	0·00376031		1·0099686	
		0·00027499		0·0007004
21·6	0·00403251		1·0106650	
		0·00027781		0·0007045
21·7	0·00430750		1·0113654	
		0·00028063		0·0007086
21·8	0·00458531		1·0120699	
		0·00028347		0·0006133
21·9	0·00486594		1·0127785	
		0·00028634		0·0008260
22	0·00514941		1·0133818	
		0·00028922		0·0007208
22·1	0·00543575		1·0142078	
		0·00029212		0·0007250
22·2	0·00572497		1·0149286	
		0·00029503		0·0007291
22·3	0·00601709		1·0156536	
		0·00029798		0·0007332
22·4	0·00631212		1·0163827	
		0·00030093		0·0007374
22·5	0·00661010		1·0171159	
		0·00029391		0·0007416
22·6	0·00691103		1·0178533	
		0·00031690		0·0007557
22·7	0·00720494		1·0185949	
		0·00030902		0·0007500
22·8	0·00762184		1·0193406	
		0·00031295		0·0007542
22·9	0·00783176		1·0200906	
		0·00031600		0·0007584
23	0·00814471		1·0208448	
		0·00031907		0·0007626
23·1	0·00846071		1·0216032	
		0·00032216		0·0007670
23·2	0·00877978		1·0223658	
		0·00032528		0·0007711
23·3	0·00910194		1·0231328	
		0·00032840		0·0007755
23·4	0·00942722		1·0239039	
		0·00033155		0·0007798
23·5	0·00975562		1·0246794	
		0·00033473		0·0007841
23·6	0·01008717		1·0254592	
		0·00033791		0·0007884
23·7	0·01042190		1·0262433	
		0·00034112		0·0007928
23·8	0·01075981		1·0270317	
		0·00034435		0·0007971
23·9	0·01110093		1·0278245	
		0·00034761		0·0008015
24	0·01144528		1·0286216	
		0·00035087		0·0008059
24·1	0·01179289		1·0294231	
		0·00035416		0·0008103
24·2	0·01214376		1·0302290	
		0·00035748		0·0008147
24·3	0·01249792		1·0310393	
		0·00036081		0·0008192
24·4	0·01285540		1·0318540	
		0·00026416		0·0008236
24·5	0·01321621		1·0326732	
		0·00036754		0·0008280
24·6	0·01358037		1·0334968	
		0·00037093		0·0008326
24·7	0·01394791		1·0343248	
		0·00037434		0·0008371
24·8	0·01431884		1·0351574	
		0·00037779		0·0008415
24·9	0·01469318		1·0359945	
		0·00397163		0·0086678
25	0·01507097		1·0368360	
		0·00433957		0·0091378
26	0·01904260		1·0455038	
		0·00473069		0·0096261
27	0·02338217		1·0546416	
		0·00514633		0·0101336
28	0·02811286		1·0642677	
		0·00558792		0·0106622
29	0·03325919		1·0744013	
		0·00605706		0·0112132
30	0·03884711		1·0850035	
		0·00655544		0·0117885
31	0·04490417		1·0962767	
		0·00708495		0·0123897
32	0·05145961		1·1080652	
		0·00764763		0·0130192
33	0·05854456		1·1204549	
		0·00824573		0·0136787
34	0·06619219		1·1334747	
		0·00888170		0·0143711
35	0·07443792		1·1471528	
		0·00955820		0·0150987
36	0·08331962		1·1615239	
		0·01027830		0·0158644
37	0·09287782		1·1766226	
38	0·10315612		1·1924870	
For Gears with a 30-deg. Design Pressure Angle				
30	0		1·0	
		0·00655544		0·0108643
31	0·00605706		1·0103341	
		0·00708495		0·0114184
32	0·01261250		1·0211984	
		0·00764763		0·0119985
33	0·01969745		1·0326168	
		0·00824573		0·0126965
34	0·02734508		1·0446153	
		0·00888170		0·0132444
35	0·03559081		1·0572218	
		0·00955820		0·0139150
36	0·04447251		1·0704662	
		0·01027830		0·0146208
37	0·05403071		1·0843812	
		0·01104510		0·0153644
38	0·06430901		1·0990020	
		0·01186230		0·0161494
39	0·07535410		1·1143664	
		0·01273380		0·0169791
40	0·08721640		1·1305158	
		0·01366410		0·0178572
41	0·09995020		1·1474949	
		0·01465771		0·0187882
42	0·11361430		1·1653521	
		0·01572040		0·0197766
43	0·12827201		1·1841403	
44	0·14399241		1·2039169	

(defined in the accompanying Table 1) agree with the AGMA Standard 111.03. Original formulae, unless otherwise indicated, are from the *Manual of Gear Design* by Earle Buckingham (The Machinery Publishing Co., Ltd.).

From fundamental equations of involute gearing, Mr. Williamson developed the relationship

$$I = (t + T - p)/2C \quad \ldots\ldots\ldots\ldots \quad (1)$$

which he used to evaluate (from given arc tooth thicknesses) the numerical difference between the involute functions of the specified pressure angle and the actual pressure angle resulting from a change in the centre distance of mating gears. The involute function difference I is then correlated by means of a table to a ratio between the cosines of the actual and design pressure angles (cosine ratio). When this cosine ratio is known, not only the new centre distance, but new meshing or pitch diameters, new circular pitch, and active pressure angles can be determined. These calculations are accomplished without having to refer to tables of trigonometrical, or of involute functions.

The following derivations illustrate the method used to eliminate cosine and involute functions from involute gear equations:

$$r_2 \cos \phi_2 = r_1 \cos \phi_1$$

and

$$d_2 \cos \phi_2 = d_1 \cos \phi_1$$

thus

$$d_2/d_1 = \cos \phi_1/\cos \phi_2 = \text{cosine ratio} \quad \ldots\ldots (2)$$

also

$$\text{cosine ratio} = C_2/C_1 \quad \ldots\ldots\ldots\ldots \quad (3)$$

Sometimes, arc tooth thicknesses at more than one diameter of the gear are required. The equation used for this purpose is as follows:

$$t_2 = d_2(t_1/d_1 + \text{inv } \phi_1 - \text{inv } \phi_2)$$

where

d_1 = first diameter;
d_2 = second diameter;
ϕ_1 = pressure angle at d_1;
ϕ_2 = pressure angle at d_2;
t_1 = arc tooth thickness at d_1;
t_2 = arc tooth thickness at d_2.

Simplifying

$$t_2 = (d_2/d_1 \times t_1) + d_2 (\text{inv } \phi_1 - \text{inv } \phi_2)$$

but

$$I = \text{inv } \phi_1 - \text{inv } \phi_2 \text{ and } d_2/d_1 = \text{cosine ratio}$$

therefore

$$t_2 = (\text{cosine ratio} \times t_1) + (d_2 \times I) \quad \ldots\ldots \quad (4)$$

and

$$t_1 = [t_2 - (d_2 \times I)]/\text{cosine ratio} \quad \ldots\ldots\ldots \quad (5)$$

In using the tables, the sign of the involute function difference becomes plus or minus, depending on whether the actual pressure angle is greater or less than the original design pressure angle.

If d_2 is not required, and the cosine ratio or I is known, equation (2) enables equation (4) to be rewritten as:

$$t_2 = (\text{cosine ratio} \times t_1) + (d_1 \times \text{cosine ratio} \times I)$$

or

$$t_2 = \text{cosine ratio } [t_1 + (d_1 \times I)] \quad \ldots\ldots \quad (6)$$

and similarly equation (5) becomes

$$t_1 = t_2/\text{cosine ratio} - (d_1 \times I) \quad \ldots\ldots\ldots \quad (7)$$

Another convenient application of the tables is in determining the circular pitch at a second diameter:

As

$$p_2 = p_1 d_2/d_1$$

therefore

$$p_2 = p_1 \text{ cosine ratio} \quad \ldots\ldots\ldots\ldots \quad (8)$$

Solving for measurements over or between pins is a brief calculation:

$$I = 1/D \, (d/\cos \phi - S) \quad \ldots\ldots\ldots\ldots \quad (9)$$

from AGMA Standard 231·51

where

D = reference diameter for known arc tooth thickness;
d = pin diameter;
ϕ = pressure angle at D;
S = arc tooth space (circular pitch less arc tooth thickness).

$$I = (1{\cdot}838899 - S)/N$$

for a standard 1·728-series measuring pin (see MACHINERY'S Handbook) for $1P$ and 20-deg. pressure angle, and

$$I = (2{\cdot}043221 - S)/N$$

for an enlarged pinion 1·92-series measuring pin for $1P$ and 20-deg. pressure angle.

After solving for I, the corresponding cosine ratio, cosine ratio$_{pin}$, can be obtained from the table, and the required pin measurements are calculated from the equations

$$D_M = (D \times \cos \text{ratio}_{pin}) \pm d \quad \ldots\ldots (10)$$

(for gears with an even number of teeth) and

$$D_M = (D \times \cos 90/N \text{ deg.} \times \cos \text{ratio}_{pin}) \pm d \quad \ldots\ldots\ldots\ldots (11)$$

(for gears with an odd number of teeth).

For example, consider a case where the gear ratio is changed but the centre distance established by the original gears is maintained in order that the same housing may be used. The resulting centre distance is "non-standard," since it does not equal one-half the sum of the

TABLE 3. FORMULAE FOR APPLYING WILLIAMSON TABLES TO GEAR CALCULATIONS

To Find	Given	Equations Required		Equation Number
Involute function difference (I)	$t\ T\ p\ C$	$I = (t + T - p)/2\ C$		1
Centre distance (C_2)	$t_1\ T_1\ p_1\ C_1$	$I = (t_1 + T_1 - p_1)/2\ C_1$		1
		$C_2 = C_1 \times$ cosine ratio		3
		(obtain cosine ratio from table)		
Tooth thickness (t_2)	$t_1\ d_1\ d_2$	cosine ratio $= d_2/d_1$		2
		$t_2 =$ (cosine ratio $\times\ t_1$) $+$ ($d_2 \times I$)		4
		(obtain I from table)		
(t_2)	$t_1\ d_1\ C_1\ C_2$	cosine ratio $= C_2/C_1$		2
		$t_2 =$ cosine ratio $[t_1 + (d_1 \times I)$		6
Circular pitch (p_2)	$p_1\ d_1\ d_2$	$p_2 = p_1\ (d_2/d_1) = p_1$ cosine ratio		8
Pin dimensions (D_M)	$S\ d\ D \cos \phi$	$I = 1/D\ (d/\cos \phi - S)$		9
		$\phi =$ any base pressure angle		
		$D_M = (D \times$ cos ratio$) + d$	even teeth, ext.	10
		$D_M = (D \times$ cos ratio$) - d$	even teeth, int.	10
		$D_M = (D \times \cos 90/N$ deg. $\times$ cos ratio$) + d$	odd teeth, ext.	11
		$D_M = (D \times \cos 90/N$ deg. $\times$ cos ratio$) - d$	odd teeth, int.	11
Diameter at which teeth become pointed (d_3)	$t_1\ d_1$ at base angle ϕ_b	$I = t_1/d_1$		12
		$d_3 = d_1 \times$ cos ratio		13

teeth in the gears used divided by the diametral pitch. (The following examples are solved for gears of 1 diametral pitch. For gears of other pitches the results are divided by the diametral pitch.)

If the new gear ratio $N/n = 154/79$, then C_1, the "standard" centre distance, $= (79 + 154)/2 = 116{\cdot}5$ in.

Other known values are:

C_2, centre distance for housing $= 119$ in.;

d_1, meshing diameter of first gear at $C_1 = 79$ in.;

ϕ_1, pressure angle at $d_1 = 20$ deg.

Solving for t_1, the arc tooth thickness of the first gear at ϕ_1,

$$t_1 = \pi/2 = 1{\cdot}570796 \text{ in.}$$

The arc tooth thickness and the dimension over pins for a close mesh can be determined as follows when the enlargement necessary to suit the increased centre distance is applied to the pinion:

$$\text{cosine ratio} = 119/116{\cdot}5 = 1{\cdot}0214592 \text{ (from Eq. 3)}$$
$$= -0{\cdot}00840063 \text{ (from table)}$$
$$d_2 = 79 \times 1{\cdot}0214592 \text{ (from Eq. 2)}$$
$$= 80{\cdot}6952768 \text{ in.}$$

$$\Delta t_1 = (d_2 - d_1) \tan \phi$$
$$= (80{\cdot}6952768 - 79) \tan 20 \text{ deg.}$$
$$= 0{\cdot}617033 \text{ in.}$$

This value is the amount of displacement required on one side of an involute gear tooth to fill the space created by the increased distance between centres.

The new arc tooth thickness is found as follows.

$$t_1 = 1{\cdot}570796 + 0{\cdot}617033 = 2{\cdot}187829 \text{ in.}$$

From Eq. (4)

$$t_2 = [1{\cdot}021459 \times 2{\cdot}187829] + [(80{\cdot}695277 \times (-0{\cdot}00840063)]$$
$$t_2 = 1{\cdot}556886 \text{ in.}$$

This value is the arc tooth thickness at the actual meshing diameter d_2. The thickness of the tooth tip may be found in the same manner.

Often it is required to know the diameter at which the tooth comes to a point (where the involutes of a tooth intersect). This diameter can be obtained as follows:

$$\text{inv } \phi_3 = t_1/d_1 + \text{inv } \phi_1 \text{ and}$$
$$d_3 = d_1 \cos \phi_1/\cos \phi_3$$
$$t_1/d_1 = \text{inv } \phi_3 - \text{inv } \phi_1$$

In this article Δ inv $= I$.

Therefore, $I = t_1/d_1 = 0{\cdot}02769403$ ..... (12)

and, from the table,

$$\text{cosine ratio} = 1{\cdot}0634158$$
$$d_3 = d_1 \text{ cosine ratio} = 84{\cdot}009848 \text{ in.} \quad (13)$$

In solving for the measurement over pins, additional data are:

$$d = 1{\cdot}92 \text{ in.}$$
$$S = \pi - t_1 = 0{\cdot}9537636 \text{ in.}$$

Using equation (9)

$$I = 1/79 \times (1{\cdot}92/0{\cdot}9396926 - 0{\cdot}9537636)$$
$$I = 0{\cdot}01379060$$

and

$$\text{cosine ratio}_{\text{pin}} = 1{\cdot}0339704 \text{ (from table)}$$

Then from equation (11)

$$D_M = 79 \times 0{\cdot}99980235 \times 1{\cdot}0339704 + 1{\cdot}92$$
$$D_M = 83{\cdot}587517 \text{ in.}$$

For a 96-pitch gear $D_M = 0{\cdot}8707$ in.

To find the centre distance for no backlash with gears of known proportions, formula (1) is used. As an example, consider 18- and 174-tooth gears with:

$$\phi = 20 \text{ deg.}$$
$$t_1 \text{ (enlarged)} = 1{\cdot}7528 \text{ in.;}$$
$$T_1 \text{ (reduced)} = 1{\cdot}542 \text{ in.}$$

Then

$$C_1 = (18 + 174)/2 = 96 \text{ in.}$$

and

$$I = (1{\cdot}7528 + 1{\cdot}542 - \pi)/(2 \times 96) \quad \ldots \quad (1)$$
$$I = 0{\cdot}000797955$$

From the table, cosine ratio = 1·0021725 and

$$C_2 = 96 \times 1{\cdot}0021725 = 96{\cdot}20856 \text{ in.}$$

For a 3-pitch gear, $C_2 = 32{\cdot}06952$ in.

The various formulae and their applications are summarized in Table 3, and Table 4 gives simplifications of formulae (9) to facilitate calculations.

TABLE 4. SIMPLIFICATIONS OF FORMULA (9) TO FACILITATE CALCULATIONS

(FORMULAE WITH CONSTANTS WHEN $\phi = 20$ DEG.)

Standard measuring pin $d = 1{\cdot}728$ in. for $1P$

(*a*) $I = (1{\cdot}838899 - S)/N$ (*b*) $I = 0{\cdot}268103/N$ (standard proportion gear)

(*c*) $I = (T_1 - 1{\cdot}3026936)/N$ (*d*) $I = (0{\cdot}268103 + \Delta T_1)/N$

($S = \pi - T_1$ or $S = 0{\cdot}5\,\pi - \Delta T_1$)

Enlarged pinion measuring pin $d = 1{\cdot}92$ for $1P$

(*a*) $I = (2{\cdot}043221 - S)/N$ (*b*) $I = (T_1 - 1{\cdot}098372)/N$ (*c*) $I = (0{\cdot}472425 + \Delta T_1)/N$

(FORMULAE WITH CONSTANTS WHEN $\phi = 30$ DEG.)

Standard measuring pin $d = 1{\cdot}728$ in. for $1P$

(*a*) $I = (1{\cdot}9953216 - S)/N$ (*b*) $I = 0{\cdot}4245256/N$ (standard proportion gear)

(*c*) $I = (T_1 - 1{\cdot}1462710)/N$ (*d*) $I = (0{\cdot}4245256 + \Delta T_1)/N$

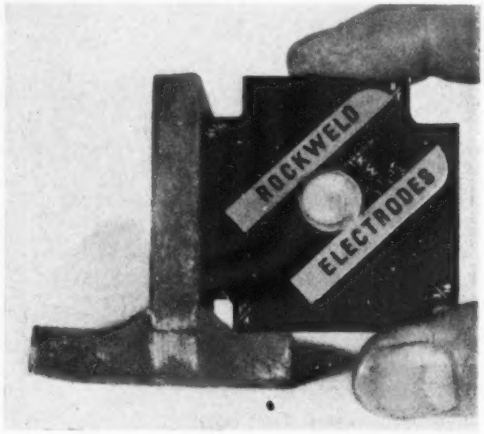
Enlarged pinion measuring pin $d = 1{\cdot}92$ in. for $1P$

(*a*) $I = (2{\cdot}217024 - S)/N$ (*b*) $I = 0{\cdot}6462280/N$ (standard proportion gear)

(*c*) $I = (0{\cdot}6462280 + \Delta T_1)/N$

Rockweld Weld Fillet Gauge

The pocket gauge seen in use in the accompanying figure has been introduced by Rockweld, Ltd., Commerce Way, Croydon, Surrey, for gauging the lengths of the legs on fillet welds. In use, the appropriate corner of the gauge is presented to the weld, as shown, the notches being marked for leg measurements of $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, and $\frac{3}{8}$ in. When the correct notch has been found, the throat dimension of the weld can be measured by means of the sliding pointer disposed diagonally across the gauge. This pointer is moved forward until it touches the weld, and the required dimension can then be read directly from the associated scale on the gauge body.



Rockweld weld fillet gauge

Italian Machine Tool Exhibition, Milan—2

An article published in MACHINERY, 93/1177—19/11/58, described a number of recently developed machine tools, which were shown at the Italian Machine Tool Exhibition organized by Unione Costruttori Italiani Macchine Utensili (U.C.I.M.U.), and held in Milan during September last. Some details are given here of other production equipment, principally of Italian make, which incorporates features of interest.

GNUTTI TYPE FMA-6M AUTOMATIC MACHINE FOR VALVE BODIES AND PIPE FITTINGS

The Italian firm Officine di Ospitaletto, Brescia, are building the 6-spindle automatic machine shown in Fig. 1 for carrying out drilling, boring, tapping, and threading operations on parts such as pipe fittings, taps, and gate valve bodies of either ferrous or non-ferrous metal, in sizes up to 1½-in. gas. Workpieces are clamped in suitable fixtures on a 5-station drum *A*, at the centre of the machine, which indexes about a horizontal axis in a clockwise direction, as viewed from the right-hand end. At the first working position, a vertical spindle comes into operation to drill a valve spindle gland hole and machine a seating face, for example, and at the next position the hole is tapped by means of a spindle head arranged at an angle at the rear. Tools in right- and left-hand horizontal spindles at the rear drill and face the end holes in the workpiece, and tapping or threading is then performed with the spindles *B* and *C* at the front. Each of the three drilling and boring spindles is driven by a 2-speed motor of 2½/3½ h.p., and steplessly-variable feed rates are provided by air-hydraulic cylinders. Tapping and threading is carried out under lead screw control, and the spindles are driven by reversible, 2¾-h.p., motors. All the control gear is conveniently mounted on a panel in the machine base, and each spindle can be operated independently if desired. Cycle times range from 5 to 15 sec., depending on the size of the component and the material. The weight of the machine is approximately 2¾ tons.

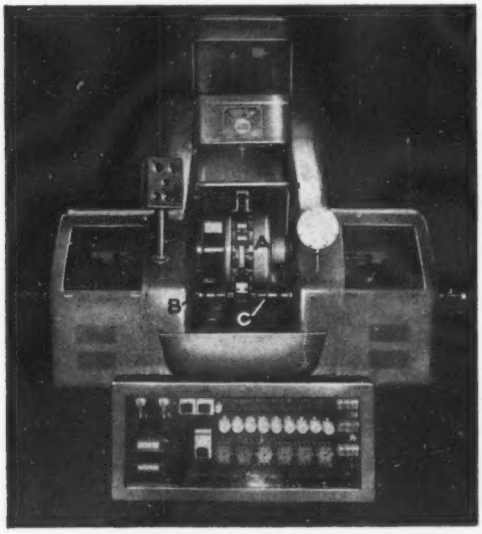


Fig. 1. Gnutti type FMA-6M automatic machine for valve bodies and pipe fittings

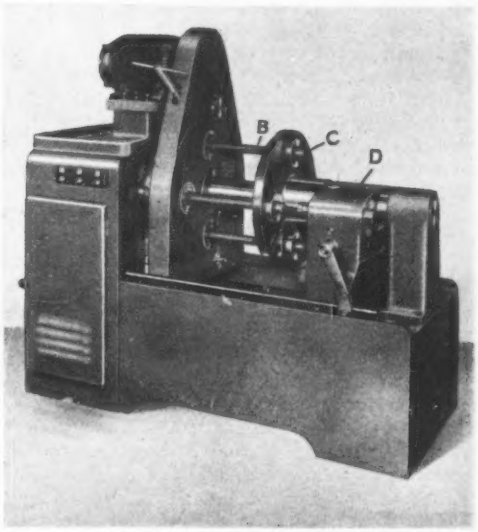


Fig. 2. Utita ICA/50 ending, centring, and boring machine

UTITA ICA/50 ENDING, CENTRING AND BORING MACHINE

In Fig. 2 is shown a double-ended machine incorporating a 4-station indexing workhead *A* with rotating chuck spindles, which is being made by

the Italian firm Officine e Fonderie-Este, Padua, for performing facing, centring, turning and boring operations on the ends of workpieces ranging from 0·4 to 2 in. diameter, with lengths from 4 to 25½ in. Known as the Utita ICA/50, this machine enables a series of preliminary operations to be performed economically on a workpiece before it is copy turned, for example, the components being loaded and unloaded in the indexing work-head at position *B*, while machining is being carried out at the remaining three stations.

The chuck spindles in the indexing head rotate in sealed ball bearings, and the drive from the 4-h.p. motor, mounted on top of the left-hand column, is transmitted through V-belts which are so arranged that the spindle at the loading position remains stationary. Of a self-centring design, the chucks are hand-operated, and two speeds of work rotation, namely 1,100 and 1,450 r.p.m., can be obtained by changing the V-belt pulley on the motor shaft. When workpieces of greater lengths than about 10 in. are being handled, an end steady *C*, incorporating chucks running in sealed ball bearings, is clamped on the central stem which carries the indexing workhead. This steady is of split construction and can readily be removed when short workpieces are to be machined.

Cross-feed and longitudinal-feed tool-holders, which are carried on the face of the main column, and on the adjustable head *D*, for performing the various operations at the three working stations, are actuated by levers and links from a cam drum, the latter being driven by a separate motor of 0·2 h.p., through electro-magnetic friction clutches whereby the feed and rapid traverse motions are obtained. Two rates of cross-feed and longitudinal feed can be obtained by changing the motor V-belt pulley, and a stroke of 1 in. is provided for the end-working tools, and of 1⅝ in. for the cross-feed tools. The machine is controlled by push-buttons, and a safety interlock ensures that the cycle cannot be started unless the workpiece is correctly clamped, and the chuck key withdrawn. Elgar Machine Tool Co., Ltd., are the agents for the machine in this country.

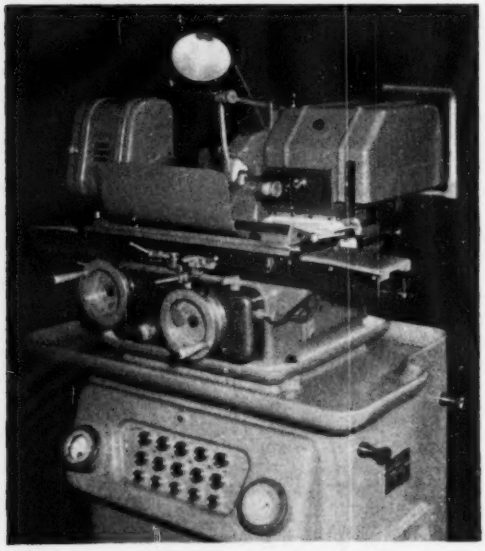


Fig. 3. Lizzini type R1-23 universal hydraulically-operated grinding machine

LIZZINI TYPE R1-23 UNIVERSAL HYDRAULIC GRINDER

Fratelli Lizzini (Elgar Machine Tool Co., Ltd.) produce a range of precision grinders which includes the small-capacity, hydraulically-operated universal machine shown in Fig. 3, with a capacity for workpieces up to 2 in. diameter by 12 in. long. Steplessly-variable speeds from zero to 160 in. per min. are provided for the table, which can also be traversed by hand, through rack and pinion. The top table is arranged to swivel through 7 deg. in each direction, to enable tapers to be ground. Drive to the swivelling workhead is taken from a motor of 0·1 h.p., and three speeds, namely 370, 550, and 750 r.p.m., are provided by V-belts and stepped pulleys. Of nitrided steel, the spindle runs in adjustable bronze bushes and is arranged to take collets or a centre.

The grinding wheel-head has a total travel of 3⅛ in., and can be moved rapidly, by means of a hand lever, through a distance of ⅛ in. Power infeed in increments from 0·0002 to 0·0012 in. can be applied at each stroke of the table. The grinding spindle is also of nitrided steel, and the front end runs in a bronze bush provided with micrometer screw adjustment, the rear end being in angular contact ball bearings. Grinding wheels up to 8 in. diameter by ¾ in. face may be employed, and the drive is provided by a motor of 0·8 h.p. Equipment available for the machine includes an internal grinding head for holes up to 2 in. diameter by 3 in. long, and a coolant separator.

MARPOSS ELECTRONIC GAUGING EQUIPMENT

The Italian firm Apparecchi Elettronici Marposs, Bologna, have developed a range of electronic gauging equipment, operating on the principle of variable capacitance, which has a wide field of application and is stated to be capable of measuring

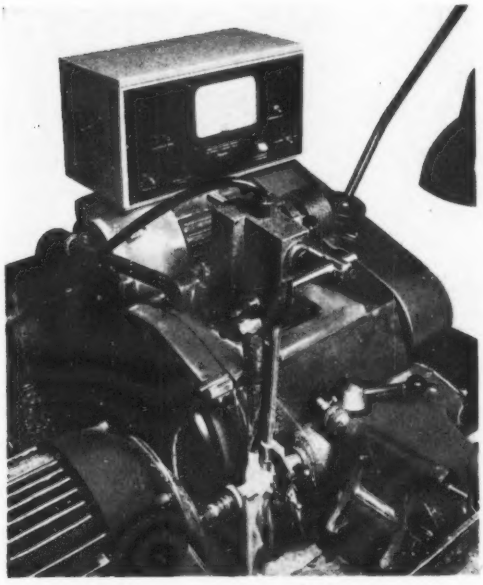


Fig. 4. Marposs caliper-type electronic sizing gauges applied to a cylindrical grinder

to an accuracy of ±0·00002 in. when used for production purposes.

For checking external diameters while grinding is in progress, both pivoted-arm and slide-mounted caliper gauge heads are available, and the pivoted arm type, known as the CFAC, is seen in use in Fig. 4. It is suitable for checking diameters from $\frac{5}{16}$ to 8 in., this range being covered by four interchangeable and adjustable forks. When the gauge is withdrawn from the workpiece, it is lifted clear by means of a spring on the pivoted arm. The instrument scale has a range of −0·003 +0·0004 in., and, if desired, controls can be incorporated for stopping the grinding machine automatically when a pre-set size is reached.

The slide-mounted gauge for external diameters, known as the type EA, is claimed to be particularly suitable for use on fully-automatic grinding machines, where the slide, mounted on the table, is operated hydraulically to advance the gauge to, and withdraw it from, the working position. It can be applied to long, slender workpieces, with diameters as small as $\frac{5}{16}$ in. or less. One of these type EA gauges is seen in use at G in Fig. 7, on an Olivetti machine. The range of application of this type of Marposs gauge-head is considerably extended by the provision of an electrically-controlled locking device for the contact points, which can be applied and released at high speed without in any way affecting the scale reading of the instrument. This device enables the gauge head to be employed for checking the outside diameter of a spline shaft, for example, during grinding. A cam on the workhead spindle actuates the switch which controls the locking device, so that the contact points are locked to prevent entry into a work gap, and are released to measure the outside diameter, as the work rotates.

A Marposs type IDAD internal gauge is seen at A in Fig. 5, mounted on a small internal grinder of high precision, known as the RIM-9S, which has been developed by the Italian firm Minganti for finishing the parallel bores and conical seatings of diesel injection nozzles. The two contact points of the gauge are located immediately behind the grinding wheel, one above and the other below the spindle, and as they leave the workpiece bore they are automatically locked. When the points enter the bore at the next grinding stroke, they are

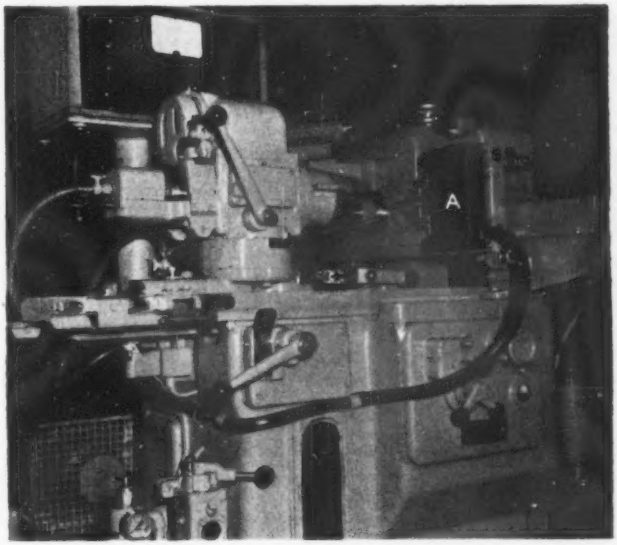


Fig. 5. Minganti internal grinder for diesel injection nozzles equipped with a Marposs automatic sizing gauge

Fig. 6. Marposs Stemar-U comparator

again unlocked. The locking device on this internal gauge can also be brought into operation when grinding splined bores, or holes with axial interruptions, for example.

Another gauge head, known as the type GA, has been developed for controlling the diameters of internal recesses, for example ball raceways, during grinding. The contact points are arranged to move towards and away from each other automatically, to enable them to enter and leave the hole, and perform their gauging function, without affecting the zero setting of the instrument. Recesses up to $\frac{1}{4}$ in. deep can be measured with the standard gauge head, and provision can be made for gauging greater depths if required. Gauge heads of the single-contact type are also made, which incorporate the locking device and can be employed on surface grinders. In addition, gauging equipment suitable for the automatic control of centreless grinders is available, and an internal or external grinding gauge can be linked to a comparator beside the machine for automatically controlling the grinding size to produce a specified fit for a selected mating part.

The Marposs range of comparator gauges includes the Stemar-U shown in Fig. 6, which can be employed for both internal and external measurement. In the illustration, the instrument is arranged for external measurement, with the piece resting on the lower circular anvil. For taking an internal measurement, it is only necessary to swing the contact arm *B* upwards to a position immediately below the pin *C*, which supports the workpiece. The instrument, as normally supplied, has an internal range of $\frac{5}{8}$ to $2\frac{5}{8}$ in., and an external range of 0 to 2 in., but contact arms and support pins for other ranges can be provided. The scale of the instrument has a range of $\pm 0{\cdot}0012$ in. Special attachments can be supplied for measuring grooves and recesses. Reference may also be made to the Stemar 1/10 internal comparator, and the Stemar EA/10 external comparator, which are capable of measuring to an accuracy of $\pm 0{\cdot}000002$ in., and have a scale range of $\pm 0{\cdot}00012$ in.

OLIVETTI CYLINDRICAL GRINDER WITH AUTOMATIC WORK HANDLING EQUIPMENT

Fig. 7 is a close-up view at the tailstock end of an Olivetti type R4-300 P hydraulic cylindrical grinder fitted with automatic work handling equipment, for grinding the 15-mm. (0·59-in.) diameter by 45-mm. (1·77-in.) long shank portion of a cast-iron sewing machine component, seen at *A* on the machine bed. Castings are loaded into an inclined magazine *B*, mounted on a bracket clamped to the machine table to the right of the tailstock *C*, and they are picked up, in turn, by hydraulically-operated grippers on an inclined slide unit *D*. The latter, together with a rear gripper slide of similar design, seen at *E*, are attached to a carriage which is moved by means of a hydraulic cylinder along overhead guideways *F*.

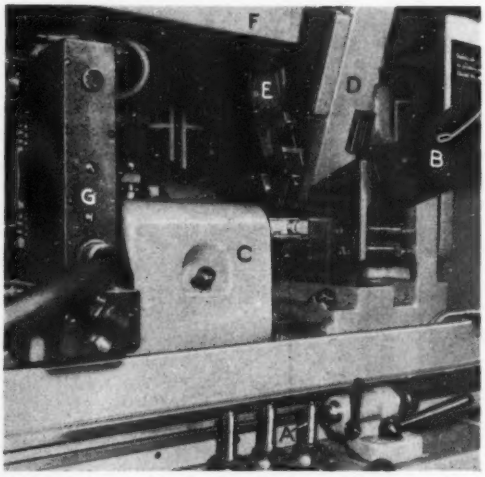


Fig. 7. Close-up view of the magazine loading mechanism for a sewing machine component on an Olivetti cylindrical grinder. Work size is controlled by a Marposs electronic gauge head

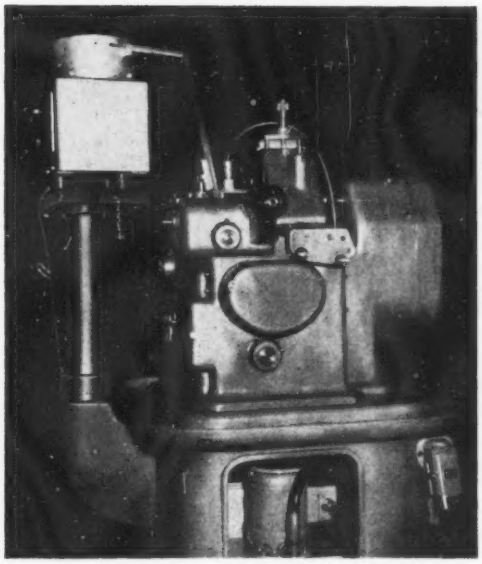


Fig. 8. Mikron type 119 pinion hobbing machine with vibratory hopper feed

When the carriage reaches the grinding position, to the left, the rear slide *E* moves down to engage the finished workpiece, and after the tailstock barrel has withdrawn, the slide rises to lift the piece clear. The front slide then moves down to load the fresh piece, which is engaged by the tailstock centre, and upon withdrawal of the loading slide, the carriage moves back to the right and the finished piece is deposited in a discharge chute. For this operation the cycle time is 30 sec., and automatic sizing to a tolerance of 0·001 in. is controlled by an electronic gauging unit supplied by the Italian firm Apparecchi Elettronici Marposs, Bologna, to which reference has already been made. The caliper gauge head, seen at *G*, is advanced automatically into engagement with the work, along a slideway, at the start of the grinding cycle.

This Olivetti hydraulic grinder is one of a range, of improved design, and normally has a grinding capacity of 10¼ in. diameter by 13⅜, 21⅜, or 33½ in. long. It is available as the type P, with an 8-speed work-head, for production purposes, or as the universal type U, with a swivelling wheel-head and a variable-speed work-head arranged for both live and dead centre grinding. The machine can also be supplied with an axially-reciprocating wheel spindle, and arranged for automatic plunge grinding.

MIKRON HOBBING MACHINE WITH HOPPER FEED

Mikron S.A. [Henry Turner (Machine Tools), Ltd.] have applied a vibratory feed hopper to their type 119 pinion hobbing machine, as shown in Fig. 8, to provide for fully automatic operation. The hopper is mounted on a pillar attached to the machine base, and the blanks, correctly orientated by a selector plate, are delivered along a slightly inclined channel into a substantially vertical magazine which incorporates a release mechanism at the lower end. Upon completion of the hobbing cycle, the tailstock retracts, the collet opens and the finished piece is ejected into a container below. The magazine then moves forward to present a fresh blank at the working position. Brass pinions, with 9 teeth of 0·5 mm. module by 4 mm. face width, were being hobbed in a cycle time of 20 sec., using a 2-start hob. This type 119 machine has a capacity for pinions and gears up

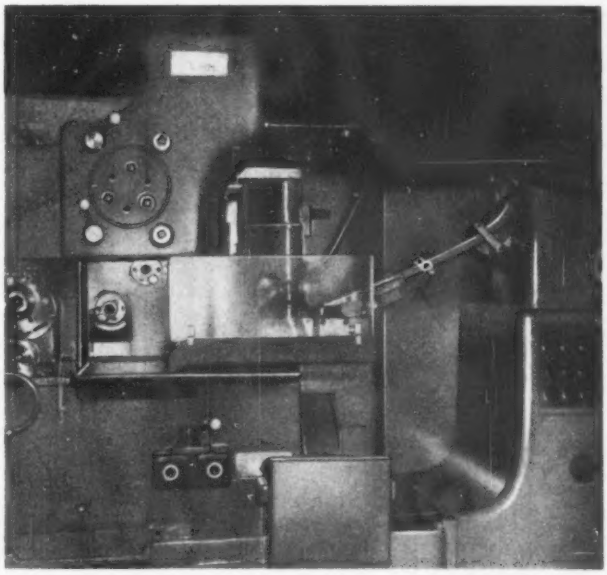


Fig. 9. Demm 8½-in capacity gear shaper with hopper feed

to 12 mm. (0·47 in.) diameter by 15 mm. (0·59 in.) long, of modules up to 0·75 mm.

DEMM TYPE SRI-220 GEAR SHAPER WITH HOPPER FEED

Shown in Fig. 9 is a Demm type SR1-220 high-speed gear shaper, built by Daldi & Matteucci Milan, which is fitted with a feed hopper of the rotary bottom plate type, as seen on the right, and set up to cut the teeth in two workpieces at once. The blanks, which are of approximately 2 in. diameter and have splined bores, move down the discharge channel *A* into a release plate, whereby they are delivered, in pairs, into nests in an indexing carrier. The latter brings the gears into position over the work spindle, and they are then engaged, from above, by a hydraulically-operated splined mandrel which enters a splined adapter in the spindle whereby the drive is transmitted. Upon completion of the gear shaping operation, the mandrel withdraws and the finished pieces are indexed by the carrier to a discharge point.

The Demm type SR1-220 machine will cut gears up to 8¾ in. diameter by 2 in. face width when using a 4-in. diameter cutter, and the maximum pitch that can be cut is 5 mm. module (5 D.P.). Six cutter speeds, from 147 to 464 strokes per min., are available, and there are 10 rates of feed ranging from 565 to 2,765 strokes per revolution of the cutter. The firm's range of gear shapers also includes the type SR16/550, of 22-in. capacity, which now incorporates a gearbox controlled by electro-magnetic clutches, whereby an increased speed can be automatically engaged when the finishing cut is to be taken.

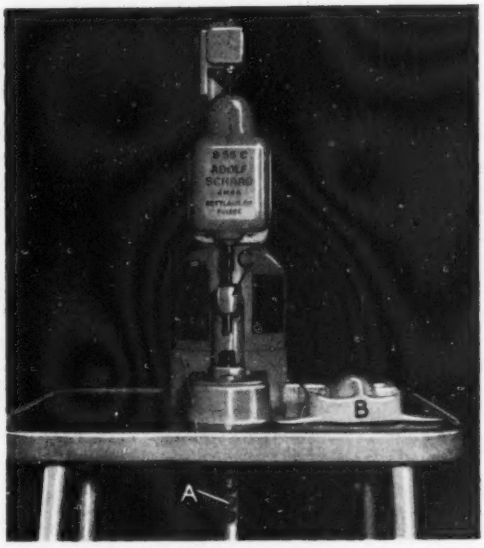


Fig. 10. Schaad type S55C riveting machine for the watch and instrument industry

SCHAAD LIGHT-DUTY RIVETING MACHINES

The Swiss firm Adolf Schaad (Matchless Machines, Ltd.) have introduced a range of electro-magnetic precision riveting machines which have been specially designed for applications in the instrument and light engineering industry, and one of these machines, known as the type S55C, is shown in Fig. 10. Both the upper and lower riveting spindles revolve, and the cycle is controlled by means of a foot lever. This lever actuates three micro-switches at A, whereby the upper and lower spindles are started, and the riveting hammer is brought into operation.

The frequency of blow may be 50

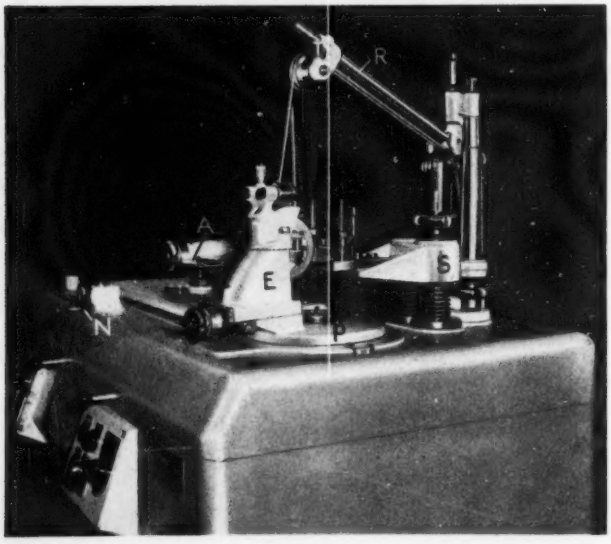


Fig. 11. Bruco template-controlled profile grinding machine

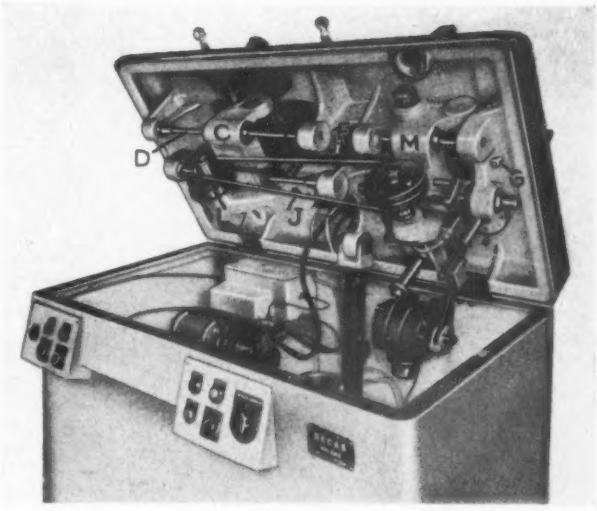


Fig. 12. A view of the Bruco profile grinder with the hinged top plate raised

or 100 per sec., and the strength, also the duration of the operation, can be pre-set on dials to suit the type of work being handled. A moulded plastics cover, seen removed at *B*, encloses the front part of the machine base and forms a container for the components to be assembled. If desired, the bracket *C*, carrying the upper and lower riveting spindles, can be removed, and the punch located directly on the hammer spindle. The power required is 225 watts, and it is stated that the machine is capable of closing a $\frac{5}{16}$ in. diameter steel rivet. If required, a vibratory hopper feed unit and an indexing work dial can be applied, and the machine will then operate continuously. A smaller machine, type SK54, is available, which has a power consumption of 165 watts, and is suitable for closing rivets up to a maximum diameter of $\frac{5}{32}$ in.

BRUCO PROFILE GRINDING MACHINE

Fig. 11 shows a template-controlled profile grinding machine, of a patented Italian design, known as the Bruco, which is marketed by Ettore Pizzochero, Via Andrea Appiani 8, Milan. It has a grinding capacity of 2⅜ in. wide by 0·6 in. deep —for greater depths there is a micrometer adjustment for the template table—and is particularly intended for operations on parts such as form tools, punch and die inserts, and profile gauges. The maximum thickness that can be ground is 2⅜ in., and the ratio between the template size and the work is 5:1.

Most of the mechanism of the machine is carried on the underside of the top plate of the base, which is hinged to permit access, as shown in Fig. 12. Feferring to Fig. 11, also the sectional drawing in Fig. 13, the template is fastened, in a horizontal position, on an adjustable holder *A*, and it is engaged, under spring pressure, by a vertical stylus pin mounted in a carriage *B*, which can move transversely along

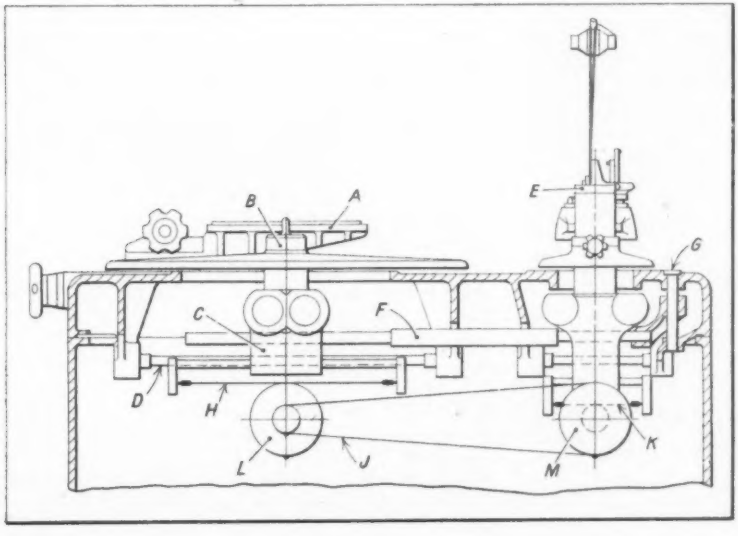


Fig. 13. Sectional view of the Bruco grinder, showing the arrangement of the stylus and grinding head carriages

two round guide bars. These guide bars are incorporated in a second carriage *C* (see also Fig. 12), which moves longitudinally on two round guides, as as *D*, anchored in brackets on the machine top plate. A similar transverse and longitudinal carriage arrangement is provided for the grinding head *E*.

Movements of the transverse carriage *B* are transmitted, in the ratio of 5:1, to the grinding head by means of a lever *F*, pivoted in the top plate casting at *G*, the arrangement being such that the two carriage system can move longitudinally while maintaining the ratio of 5:1. The longitudinal movements of the carriage *C* are transmitted to the grinding head through the medium of steel tapes *H*, *J*, and *K* which pass over 2-step drums *L* and *M*, the diameters of the latter providing the required ratio of 5:1. These drums rotate in bearing brackets attached to the top plate as may be seen in Fig. 12. Provision is made for traversing the stylus pin smoothly over the template by means of a small handwheel, seen at *N* in Fig. 11, which, through a gearbox, moves the longitudinal carriage *C*. If desired, the handwheel can be disengaged and the stylus moved directly by hand.

The grinding head *E*, Fig. 11, can be adjusted horizontally by screw and handwheel along a base member *P*, which is pivoted on a vertical axis in the transverse carriage immediately beneath. An adjustment of 90 deg. is provided, which enables the wheel to be presented to the work at the most effective angle. Grinding wheels up to 4¾ in. diameter may be employed, and the wheel is mounted on a bushed sleeve which runs on a stud clamped in the head casting. The nut for clamping the wheel on the sleeve also forms a V-grooved pulley for the round driving belt, and with this arrangement, the complete wheel and bearing assembly can readily be removed from the machine. Adjustable weights on the sleeve enable the assembly to be accurately balanced. Drive to the spindle is taken from a small motor located beneath the machine top plate, and the round belt passes over guide pulleys on an overhead tension arm *R*. A diamond dressing device, located on the pivot axis of the grinding head base *P*, is provided for truing the wheel periphery to a radius corresponding with that of the stylus pin. There is also a dial gauge attachment which enables a wheel already dressed to a radius to be accurately set in relation to the pivot axis, by screw adjustment of the wheel-head slide. The work-holding unit S moves vertically on two round guides and is reciprocated hydraulically, the traverse speed being steplessly variable from 5 to 16 ft. per min. Pressure oil is supplied by a small pump unit housed in the base.

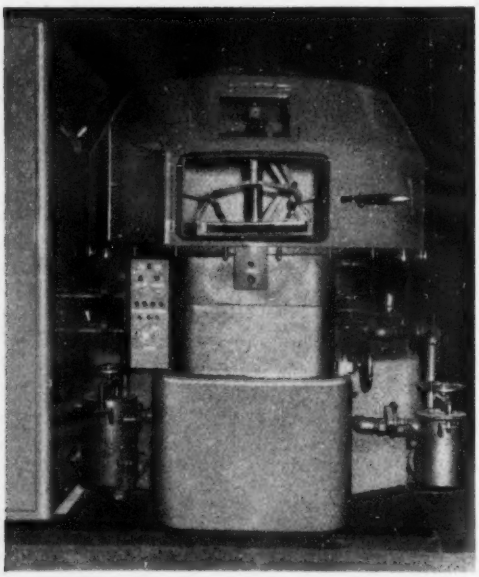


Fig. 14. Maestrelli automatic degreasing and cleaning equipment

MAESTRELLI AUTOMATIC DEGREASING AND CLEANING EQUIPMENT

A 3-stage automatic trichlorethylene degreasing unit for high-production applications, which is shown in Fig. 14, has been introduced by G. Maestrelli, Milan. Access for loading and unloading is afforded by a door, whereby the unit can be totally enclosed, and the work to be cleaned is placed in wire-mesh baskets. There are four baskets, attached to a carrier, which is indexed in a clockwise direction and is also lowered and then raised, by means of an air cylinder, after each indexing cycle, to immerse the work in the cleaning baths.

In the figure, the carrier is seen in the raised position, with the door open for loading and unloading a basket. At the first cleaning station, the work is immersed in a bath of hot solvent, and at the next the greater part of the grease and dirt is removed by high-pressure solvent jets. At the third stage, cleaning is completed by trichlorethylene vapour which condenses and is re-circulated. The unit is push-button controlled, and the immersion time can be varied from 1 to 20 min. by means of a timer, to suit the type of work being handled. Solvent pumps and supply tanks are housed in the cubicle seen on the left.

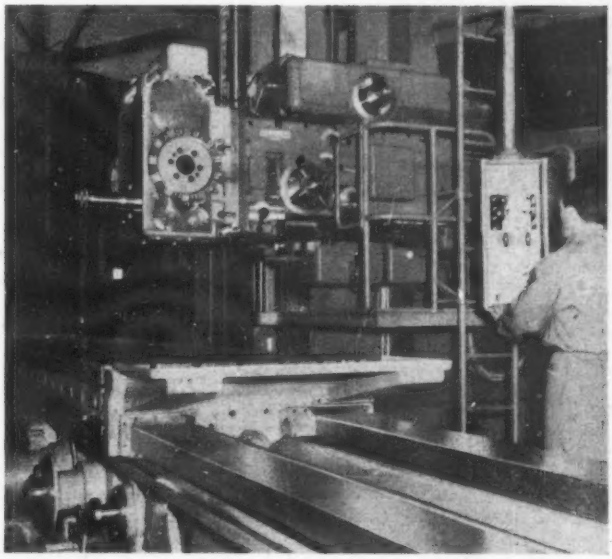


Fig. 15. Innocenti-Berthiez type FAP 140/95 plano-milling and boring machine

INNOCENTI-BERTHIEZ PLANO-MILLING AND BORING MACHINE

One of the range of plano-milling and boring machines of Berthiez design built by Innocenti, Milan (Henderson & Keay, Ltd.), is shown in Fig. 15, equipped with a special double-ended milling head which is bolted to the end of the rectangular-section ram, and driven from the main spindle. For these Innocenti-Berthiez machines, a wide range of equipment is available, which enables a comprehensive series of operations to be carried out on a workpiece at the one setting. In addition to various types of universal milling heads and facing heads, there are indexing turret heads with four or eight tool positions, and rotary tables can be provided with floor-type machines which, in conjunction with ram-type tool-holders, permit turning and boring operations to be performed.

The machine illustrated, designated type 140/95, has a 5½-in. diameter milling spindle and a 3⅞-in. diameter boring spindle, the latter having a travel of 39⅜ in. The traverse of the spindle ram horizontally in the saddle is 15¾ in., and the saddle has a vertical travel on the column of 63 in., or, with an extended column, 87 in. A cross travel of 39⅜ in. is provided for the column along its bed, in the direction of the spindle axis, and the traverse of the table is 16 ft. 6 in.

All the traverse motions are effected by means of screws, driven by variable-speed motors which provide a stepless range of feeds from 0·025 to 63 in. per min., and rapid traverse at 87 in. per min. The spindle speeds also are steplessly variable, and range from 6 to 1,000 r.p.m., the drive being taken from a 25-h.p. D.C. motor. Positioning of the table, column, spindle saddle and spindle ram can be obtained automatically, by power, to an accuracy, it is claimed, of 0·0004 in., by means of end measuring rods which actuate trip switches, and readings for all movements can be obtained directly, on dial gauges or vernier scales. Adjustable dogs permit automatic cycles to be set for rapid approach, engagement of slow feed changing to normal feed, reduction of the feed rate towards the end of a cut, disengagement of feed, and rapid return. If required, a 6- or 8-station indexing drum, carrying trip dogs, can be fitted for each movement, which permits a series of different automatic cycles to be performed.

A feature on all sizes of Innocenti-Berthiez machines is a patented system of counterbalancing for the spindle saddle on the column, which ensures smooth and sensitive vertical movement, and uniform load distribution on the slideways irrespective of any variation in the total weight resulting from the use of the various attachments. The spindle saddle, which may weigh from 2 to 8 tons, according to the size of the machine, is balanced hydraulically by means of a ram on the column base, at the rear, to which oil is supplied by a variable-delivery pump. Delivery pressures to which the pump should be set when using the different attachments are indicated on a gauge, and an accumulator is incorporated in the system to maintain the balancing pressure when the machine is stopped.

In addition, provision is made for varying the coupling point of the suspension chain on the saddle, in the direction of the spindle axis, to obtain the most effective conditions of balance. To compensate for variations in the loading of the horizontal column ways resulting from differences in the overhung weight of the spindle saddle, hydraulic support is provided by two lubricating pumps, so arranged that a selected pressure difference is maintained between the right- and left-hand ways.

New Range of Churchill Heavy-duty Roll Grinding Machines

A new range of heavy-duty, travelling wheel-head, grinding machines has recently been developed by The Churchill Machine Tool Co., Ltd., Broadheath, near Manchester, for grinding parallel and cambered mill rolls. There are three machines in the range, known as the types TWA, TWB, and TWR, with capacities for grinding rolls with maximum diameters of 32, 42, and 66 in., respectively. In view of the duties for which these machines are intended, particular attention has been paid in the design to rigidity, accuracy, and smoothness of operation, also to the provision of ample power for the grinding wheel and work-head drives to enable high rates of metal removal to be obtained. All machines in the range are equipped with the patented Churchill automatic electronic feed system, whereby maximum use is made of the power available from the grinding wheel motor.

A type TWB machine, which admits 192 in. between centres, has recently been installed at the Abbey Works of the Steel Company of Wales, Ltd., Port Talbot, where it is employed for servicing rolls used on a Davy United cold strip mill. While undergoing trials at the builder's works before despatch, this machine satisfactorily ground 0·024 in. from a 20½-in. diameter by 80-in. long, hardened, forged steel roll in only 15 min. It is also reported that during the tests a surface finish of 1·5 to 2 micro-inches was obtained on a hardened steel roll. Only three wheels were used, and for finishing the grit size was 400. A general view of this TWB machine is given in Fig. 1, which affords an indication of the massive proportions of the main members. In this illustration, the two bed sections can be clearly seen, that at the front having broad flat ways to support the travelling wheel-head, and that at the rear being provided with one inverted-vee and one angled flat way for the work-head and tailstock units. The machine has an overall width of 15 ft., an overall length of 31 ft. 6 in., and weighs 76 tons.

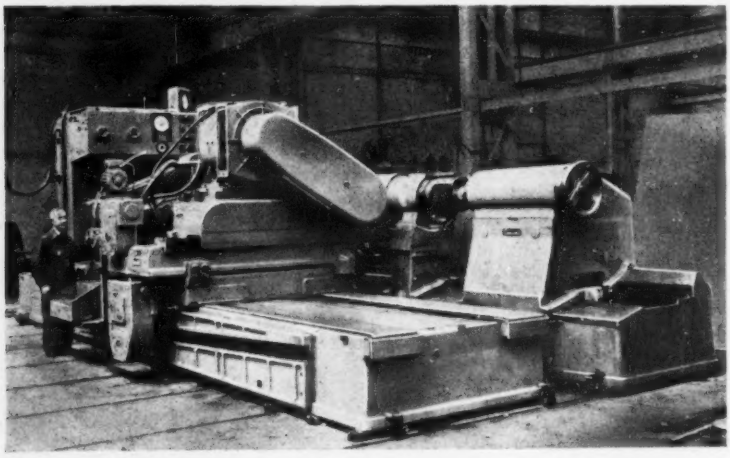


Fig. 1. General view of the type TWB 42- by 192-in. heavy-duty roll grinder, which is one of a new range of machines recently introduced by The Churchill Machine Tool Co., Ltd.

WORK-HEAD AND TAILSTOCK

A close-up view of the machine is given in Fig. 2, and shows the tailstock, the work supports, and the front face of the work-head. The latter is driven by a 20-h.p. D.C., variable speed motor, through multiple V-belts, and provides a speed range of 15 to 60 r.p.m. Attached to the compensating driving plate is the 46½-in. diameter final drive pulley, which is mounted on a pair of widely-spaced, 18¾-in. bore, taper roller bearings. For starting, stopping, and inching the work-head, also for varying the speed, there are two sets of push-buttons, one incorporated in the main control panel and the other built into the head, for convenience of operation during setting-up.

The tailstock, at the left in Fig. 2, comprises a base member, and a top portion which can be set over for alignment purposes and clamped

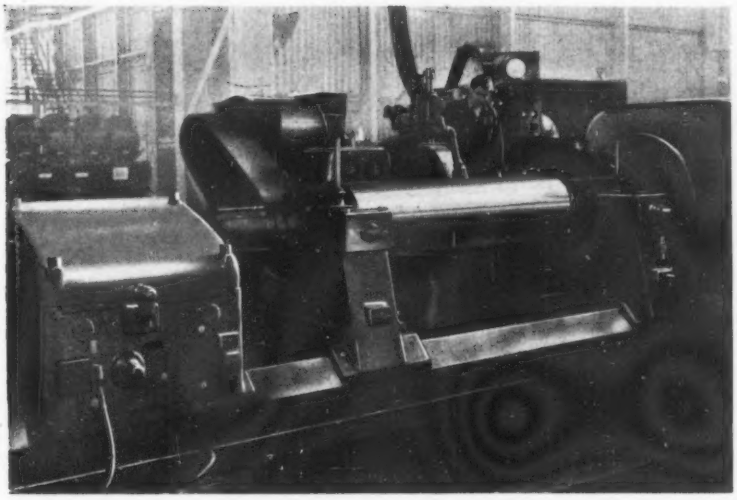


Fig. 2. Close-up view, showing the work side of the machine seen in Fig. 1. The work-head and the tailstock are of the dead-centre type, and the roll is carried on white-metal-lined pads in the work support castings

by means of bolts and T-nuts. Both the work-head and the tailstock incorporate dead centres, and can be traversed along the bed by power, a worm reduction unit and push-button controlled motor being provided in each unit for this purpose. Each assembly has a heavy steel sprag, arranged to engage with a rack in the throat of the bed, to assist the clamp bolts which are provided for securing it in the required position. The work supports incorporate adjustable white-metal-lined pads, in which the journals of the roll rest, and these pads are readily interchangeable to suit different journal diameters.

DESIGN OF THE WHEEL-HEAD

The wheel-head has a large-diameter nitralloy spindle running in adjustable leaded-bronze cone bearings which are lubricated by an independent motorized pump unit drawing oil from a large-capacity reservoir within the head casting. Drive is taken from a 40-h.p. variable-speed motor, through multiple V-belts, and the speed range is 345 to 690 r.p.m. The spindle is designed to carry a standard 36-in. diameter by 4-in. wide grinding wheel, and has a 1 in 8 taper nose and a driving key.

To assist in maintaining the wheel-head at a constant temperature during operation, a fan-cooled radiator block is incorporated through which the lubricating oil is passed before it is recirculated to the bearings. There are three filters in this lubricating system, and pressure switches are provided to ensure that the spindle cannot be run until pressure oil is available, and, conversely, to shut off the spindle motor should the oil pressure fall during operation. Power for traversing the wheel-head along its bed is taken from a 5-h.p., Ward Leonard-controlled, reversing motor, through a gearbox, to provide feed rates ranging from 3 to 110 in. per min. The final drive section of this gearbox incorporates a worm and wheel reduction unit which drives a pinion meshing with a rack attached to the bed. This rack is housed in a trough which is flooded with oil to ensure continuous lubrication.

Control of the length of traverse of the wheel-head is provided by dogs which are adjustable around the periphery of a drum on the front face of the gearbox and operate a heavy-duty reversing switch incorporated in the gearbox cover. The slideways on the wheel-head bed are fitted with permanent flexible covers, to prevent the ingress of dirt, and provision is made at the ends of the bed for re-tensioning these covers should stretch occur. These slideways are lubricated by oil from a pump within the wheel-head, and pressure switches are incorporated in the circuit to monitor the supply and pressure of the oil. For control of the wheel-head traverse motion, there are push-buttons on the main panel, also a lever-operated switch on the gearbox which enables the direction to be reversed at any point in the travel. The electrical circuit incorporates an adjustable electronically-controlled dwell switch, whereby the wheel-head can be caused to pause before reversal, to ensure that the extreme ends of the roll are fully ground. A close-up view of the operating position is shown in Fig. 3, where the main control panel can be seen at the upper left, also the traverse control drum on the front face of the gearbox. Hand-wheel-operated regulators are provided for controlling the rate of traverse of the wheel-head, also the wheel

spindle speed, and each is fitted with a suitably-calibrated dial. The large white-faced instrument in the centre of the control panel is a tachometer for registering the speed of the work, which can be steplessly-varied by means of the two push-buttons seen below this instrument. An ammeter is included to indicate the horse-power absorbed by the grinding wheel during operation.

AUTOMATIC ELECTRONIC FEED

As already mentioned, all the machines in this range are equipped with the patented Churchill automatic electronic feed system. With this arrangement, feed is automatically applied to the grinding wheel immediately a fall in current at the wheel motor is detected, and it is thus ensured that the cut is kept constant at a pre-selected amount during the complete longitudinal traverse. The predetermined load on the motor can be adjusted over a wide range, and can be set, for example, so that the power only suffices to drive the grinding spindle, without any cut taking place. For finish grinding, for instance, the system can be set for successively smaller loads as the finish on the roll is built up, and is capable of automatically applying increments of feed smaller than would be possible by the hand control. The latter it may be noted is graduated for 0·000125 in. cut per division. This control system can also be used with good effect after the wheel has been trued. By adjusting it to a very low setting, the grinding wheel can be advanced until it just makes contact with the work, and the risk of "digging in" is therefore avoided.

CAMBER GRINDING

These machines are fitted with an improved version of the well-known, patented, Churchill cambering mechanism whereby a camber or crown can be ground on a roll by rocking the grinding wheel towards or away from the work during the longitudinal traverse. A close-up view of the newly-designed mechanism, which will produce a wide range of special camber and high-lift crown forms, is given in Fig. 4. The camber bar indicated at *A*, which can also be seen on the front of the wheel-head bed in Fig. 1, has a machined slot wherein the slipper attached to the end of the lever *B* is arranged to slide. The lever *B* is pivoted on a bracket *C*, attached to the wheel-head carriage. As the slipper is traversed along the inclined slot in the camber bar its vertical movement causes the lever *B* to pivot and impart rotary motion to the U-shaped member *D*. When this member turns, a cam on its flat top surface imparts angular movement to the lever *E*, which is pivoted on the bracket *C* at its right-hand end, as viewed in the figure. This movement is transferred to the lever *F*, which is also pivoted to the bracket *C*, but at its left-hand end.

On the upper surface of the lever *F* there is a ball, located within the ring *G*, which is in contact with the under-side of the wheel-head casting. Since this member is trunnion-mounted on the carriage at its front end, the rise and fall of the lever *F* is transmitted directly to the wheel-head, to rock the grinding wheel towards and away from the work. The extent of the movement which is transmitted

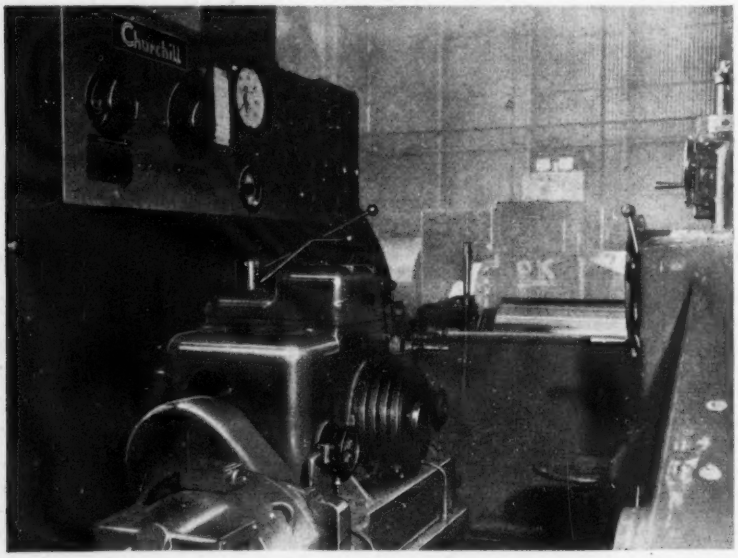


Fig. 3. Close-up view of the operating position for the Churchill type TWB roll grinder. The main control panel can be seen at the upper left, and the wheel-head carriage traverse gearbox, and the drum for controlling the length of traverse of the carriage, are seen in the centre

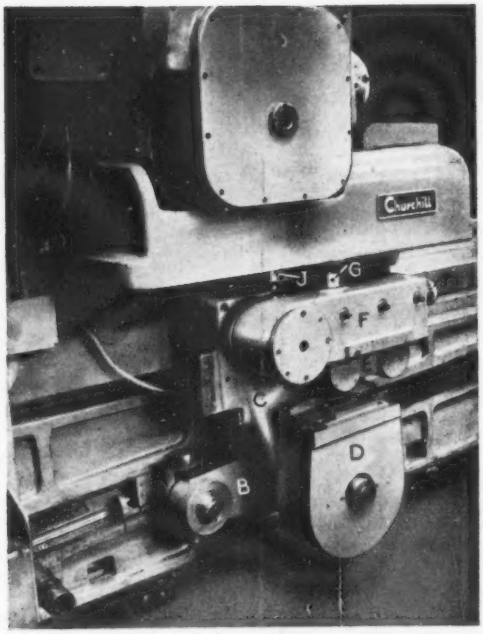


Fig. 4. The improved cambering mechanism which is fitted to all the machines in the new range of Churchill roll grinders. Motion is derived from the action of a slipper in an inclined camber bar, and the mechanism incorporates an interchangeable cam to enable a wide variety of special cambers and crowns to be ground

from the lever *E* to the lever *F* can be varied by adjustment of the connecting piece between the two members, this adjustment being effected by means of the knob *H* in conjunction with the scale seen on the front of the lever *F*. A capstan-operated jack screw, just visible at *J*, can be raised to make contact with the wheel-head casting to support its weight while the cambering mechanism is being set, also to allow parallel rolls to be ground.

No pins or keys are employed in the cambering mechanism for connecting the various parts, and the possibility of backlash or lost motion is therefore eliminated. The cam piece on top of the member *D* is readily interchangeable with others of different forms, and the mechanism can thus be adapted for producing a wide variety of profiles on the rolls.

Additional equipment available for this machine includes an auxiliary wheel-head which can be used for grinding taper necks on rolls. This wheel-head is mounted on a separate carriage on the wheel-head bed, and has a 30-in. diameter grinding wheel of the same width and bore size as the main wheel. When in use, the auxiliary carriage is locked to the bed and its associated wheel-head is traversed on a swivel slide which can be set to the required angle. Tapers up to a maximum included angle of 12 deg. can be ground with this attachment. Accessories available also include radius truing attachments, centre grinding attachments, wheel balancing stands, and roll gauging instruments.

All the motors on these machines are specially built and balanced, including that for the coolant system. A magnetic coolant filter is provided as standard, but alternative types of filtration equipment, such as those in which the element is of fabric, can be supplied to customers' requirements.

THERMO-ELECTRON ENGINE—An arrangement for converting atomic heat directly into electricity would greatly simplify atomic energy installations. Such a unit has recently been invented by Assistant Professor George N. Hatsopoules and Professor Joseph Kaye, of the Massachusetts Institute of Technology, and a laboratory scale prototype has been constructed.

This device, which has been termed a "thermo-electron engine," operates without any moving parts and is based on the principle that if two metal plates are placed opposite each other in a vacuum tube, and one plate is constantly supplied with heat, to maintain its temperature above that of the other, a constant stream of electrons passes from the hot plate to the cold plate. This stream constitutes an electric current which can be used externally for any conventional purpose.

In the experimental tube, the hot plate is held at about 2,200 deg. F. and the temperature of the "cold" plate, which is only about 0·001 in. away, is approximately 1,000 deg. F. A thermal efficiency of 12 per cent has so far been attained, but it is believed that an efficiency of 30 per cent may eventually be reached. Apart from the advantages of having no moving parts and requiring virtually no maintenance, such engines could be made in any size required—small for use in missiles and satellites and very large for atomic plants. On the basis of the existing model, it appears that a relatively efficient power plant could be built to yield 5,000 to 15,000 watts per cu. ft. of total plant volume.

The same investigators, it is reported, are working on another "engine" in which intersecting electric and magnetic fields will be utilized to control the flow of electrons.

E.M.I. Electronics Exhibition

An exhibition, concerned with some of the fields in which they are now engaged, was held recently by E.M.I. Electronics, Ltd., at the Hayes Works, Middlesex, of the E.M.I. organization. The work of the Industrial Applications Division of the company, particularly in the field of machine tool control, has already been the subject of articles in MACHINERY, and the E.M.I. system is now well established. One of the latest developments, designed to extend the range of application of automatic positioning control in both large and small works, is the introduction of a 10- by 10-in. capacity co-ordinate table which can usefully be employed, for example, on a standard pillar drilling machine, as shown in Fig. 1.

The control cabinet, with tape reader, seen on the right, together with the drilling machine and co-ordinate table, form a relatively inexpensive installation which enables a wide variety of work-pieces to be economically drilled in either large or small batches, without the need for jigs. Provided the component drawing dimesions are indicated as co-ordinates from a datum point, the paper tape can readily be prepared by a typist on a Creed teleprinter, and the one tape serves for virtually any number of components.

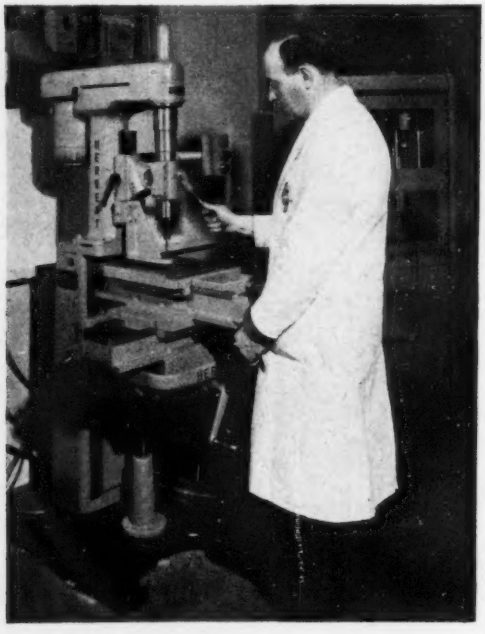


Fig. 1. A pillar drilling machine equipped with the recently-developed 10- by 10-in. co-ordinate table controlled by an E.M.I. automatic positioning system using punched paper tape

The compound table has a working surface of 10 by 10 in., and an easy, sensitive motion is ensured by the use of Dexter linear anti-friction guidways of the re-circulating ball type, which were described in MACHINERY, 89/912—19/9/56. Table movements are effected by an air-hydraulic system controlled by solenoid valves. Air at a pressure of 65 to 100 lb. per sq. in., from the shop line, is supplied by way of an adjustable reducing valve to pressurize double-acting cylinders containing oil, one cylinder being employed for the longitudinal, and another for the transverse motion. The cylinders are maintained full of oil at both sides of the pistons, and locking, after the co-ordinate setting has been made, is accomplished by closing the valves at each end.

The basic measuring elements are Inductosyn units, the application of which, in the E.M.I control system, was described in MACHINERY, 90/1062—10/5/57. The Inductosyn is essentially an air-coil inductive coupling formed by two insulating elements whereon are printed metallic conductor patterns which function in the same manner as the windings of a standard synchro or resolver, in that an electro-magnetic coupling is obtained between the two elements, and varies according to their relative positions. The units incorporated in the machine shown have an electrical accuracy of ± 0·0005 in. They were produced by a printed circuit technique on a base plate of insulating material approximately ⅛ in. thick, from a master Inductosyn prepared on glass, which was supplied by Farrand Controls Inc., New York, U.S.A., who were responsible for developing the Inductosyn system. The insulating base is attached, in turn, to a ¼-in. thick ground steel plate.

The pitch of the Inductosyn is 0·100 in. and the initial movement of the table, to within slightly less than 0·050 in. of the position required, is controlled by slider-type potentiometers on the x and y axes.

This approach movement is carried out at a speed which is adjustable up to 120 in. per min., and the speed is reduced to a constant rate of 2 in. per min., determined by the setting of a needle

valve, while the motion is under the control of the Inductosyn, whereby the final position is determined. Co-ordinate settings can be made to an accuracy of ±0·002 in., and the accuracy of repeatability is 0·001 in.

Information can be fed into the control system by means of 5-hole teleprinter tape. Alternatively, co-ordinates may be set up on dials and the table position cycle initiated by push button. The position of the table is represented by an analogue voltage, as is the required position set up in the store unit of the control panel, either by tape or manual selection. A comparison is made of these two analogue voltages and the difference is amplified, the output being so arranged as to drive the table in a manner which reduces this difference to zero. Under tape control, ordinates of x and y are read alternatively from the tape, and the output of the readers operates the store unit to set up the desired position analogue voltages, and initiate the automatic cycle. On the machine shown, the spindle feed is applied by hand, but it would readily be possible to fit a self-contained air-hydraulic unit of conventional design to provide a fully-automatic cycle of rapid approach, feed, and rapid return, controlled by the tape. The height of the compound table unit is 9 in., and it is designed to carry loads up to 100 lb.

Reference has already been made in MACHINERY, 91/715—20/9/57, to the Atlantic co-ordinate drilling machine with tape control which was built to E.M.I. requirements by Industrial Technics (Southampton), Ltd., and first demonstrated at the Fifth European Machine Tool Exhibition at Hanover in 1957. This bridge-type machine, which has a table measuring 36 by 30 in., and a drilling area of 30 by 24 in., has since been employed, at the E.M.I. works at Hayes, for drilling a variety of panel and chassis components requiring large numbers of holes. It is stated that, on this type of work, which would otherwise have to be marked out by manual methods, the cost of the machine can be recovered in 12 months.

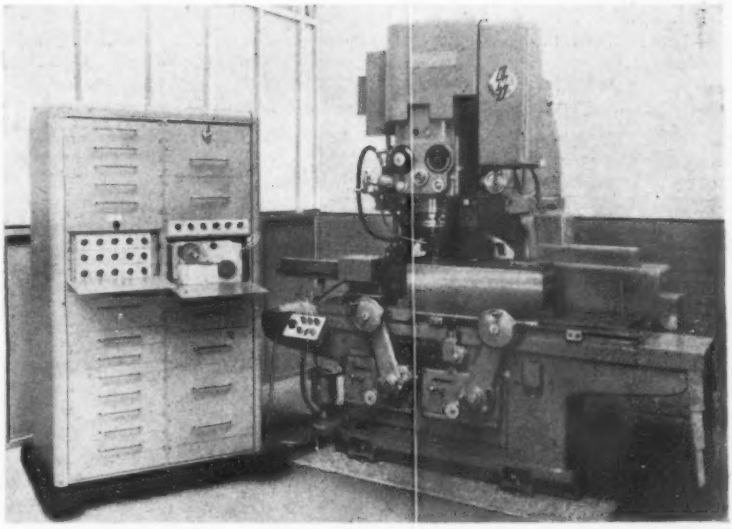


Fig. 2. Cincinnati Hydrotel hydraulic profiling machine incorporating the E.M.I. control system

Of particular interest among the operations at present being carried out on this machine is the drilling of ⅜-in. thick aluminium alloy plates measuring 24 by 28 in., which form master boards for use in connection with printed circuit techniques. In each plate, 12,000 holes of ⅛ in. diameter are drilled at a spacing of 0·2 by 0·2 in., accurate to ± 0·002 in., and it will be appreciated that the work would be very expensive if carried out on a conventional jig borer, or with the aid of a jig. On the Atlantic tape-controlled machine, five plates are stacked and drilled at once, the cycle time for each hole being 8 sec. Each row of holes is drilled automatically, without attention from the machine operator, who then sets up the required spacing of 0·2 in. on the dial and depresses a push button to initiate the cycle for drilling the next row. With this arrangement, only a short tape is required.

Circular Inductosyns are also available, and a 16-in. rotary table of E.M.I. design was demonstrated at the exhibition in conjunction with a control unit which enabled angular settings to be selected on dials, or obtained automatically from punched tape. Optical Measuring Tools, Ltd., it may be noted, are producing a 30-in. rotary table fitted with a 12-in. Inductosyn, and controlled by the E.M.I. positioning system. The setting accuracy of this table is stated to be within ±3 sec. (repeating to ±1 sec.) and an unlimited number of settings can be obtained. The speed of rotation is

2½ r.p.m., and the table will carry loads up to 10 cwt. Machine tools to which the E.M.I. analogue system has been applied for profiling control include Cincinnati and C.V.A.-Kearney & Trecker knee-type milling machines, and Cincinnati Hydrotel hydraulic profilers. One of the latter, which was demonstrated at the recent exhibition, is shown in Fig. 2. The system provides for 3-dimensional tape control, and Moog high-response servo-valves, specially developed for such applications in the U.S.A., are incorporated in the hydraulic system. Arrangements have now been made for the manufacture of the valves in this country by Dowty Equipment, Ltd.

An interesting example of the application of electronics in another industrial field is afforded by the Emiway weighing control system, and a demonstration unit is illustrated in Fig. 3. The weights of materials to be discharged from storage bins can be set up on dials, or programmes can be prepared on punched card or tape, and facilities for automatically switching from fast to slow delivery from the bin are provided. The tare weight of containers is automatically recorded before the flow of material starts, and remote indication of the operation of the system can be provided, the display giving in-line indication with illuminated digits. Electric typewriters, teleprinters, or card or tape punches can be incorporated in the system, so that weights and other relevant data can be automatically recorded. Any conventional type of dial scale with a pointer shaft to which a transducer can be coupled, may be employed. The transducer is connected electrically to servo equipment in the control cabinet, to which is geared a Hilger & Watts digitizer disc. The latter converts pointer shaft angle to an unambiguous digital code, and this information is decoded electronically.

Other products to which attention was drawn included induction and dielectric heating equipment, dynamic balancing machines, oscilloscopes and stroboscopes, tachometers, vibration equipment for testing purposes, television cameras for industrial and broadcasting applications, including an improved design for colour television, and a recently-developed device for reading figures. The demonstration of this device showed how numbered trucks could be sorted on a model railway system. Figures in a special type-face can also be read from tape at high speed, and printed out on an electric typewriter. As an alternative to the optical scanning method, figures produced in magnetic inks can be read magnetically.

Included among the stroboscopic equipment is the Autostrobe instrument which has been developed to provide a means of synchronizing a stroboscope with either an oscillator or an electro-mechanical transducer giving a sinusoidal output. It permits a pre-determined difference frequency to be maintained between a varying frequency source and an electronic stroboscope. This facility is of particular advantage when visual observations are being carried out during vibration testing, because it allows an apparent slow motion effect to be maintained at a constant rate while the frequency applied to the vibration generator is changing. Likewise, the same effect can be achieved when it is desired to observe any form of fast mechanical movement, while it is undergoing changes of speed. Another feature of this unit is that the phase relationship between the source and the stroboscope can be varied between zero and 360 deg., thus enabling the moving component under observation to be "frozen" at any point of its travel. The instru-

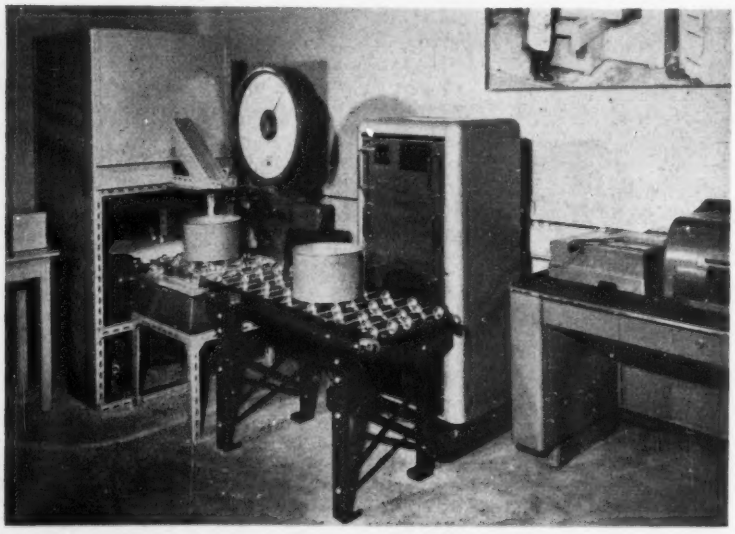


Fig. 3. Demonstration unit to show the operation of the E.M.I. electronic weighing control system

ment can be supplied for bench mounting, or without a case, for rack mounting, and a remote control unit is available.

In the field of vibration measurement, attention is drawn to the E.M.I. type 3 accelerometer, comprising a small unit with a hexagonal body and a threaded end, which is screwed into a tapped hole in the component under investigation. The device consists of a disc of polarized barium titanate, sandwiched between a given mass and the body of the unit. When the accelerometer is attached to a vibrating body, the change in velocity and direction during each cycle of vibration causes the mass (inertia weight) to compress or release the disc of barium titanate with a force proportional to the acceleration. Owing to the piezo-electric properties of the barium titanate, when it is subjected to mechanical stress in this manner, a voltage is developed which is proportional to the strain, and hence to the acceleration. The unit is intended for use with the E.M.I. type 1A cathode follower, and an oscilloscope or valve voltmeter may be employed as the indicating instrument. E.M.I. Electronics, Ltd., also presented an extensive exhibit at the Electronic Computer Exhibition held at Olympia, London, from November 28 to December 4.

Letters to the Editor

[The Editor does not hold himself responsible for the views expressed by his correspondents.]

A Second Language

(*To the Editor of* MACHINERY)

SIR,—The leading article in MACHINERY, 93/1035—5/11/58, concerning the need for a second language for use in the exchange of technical information on an international scale presents a very clear picture of the difficulties that now exist.

I think, however, that the suggested solution, that British engineers should learn Russian (assuming also that they have already mastered French or German) would be very incomplete. Apart from the fact that the technician in this country needs to keep abreast of developments abroad, modern transport has provided the means of bringing together the engineers of all countries. Contact through the printed word is certainly very desirable, but it must be complemented by verbal intercourse under conditions of impartiality. If Russian is to become the diplomatic language of engineering—as suggested—the advantages will always be with the native speakers. Surely it would be preferable to support a neutral language which would have widespread advantages in application, mutually enjoyed by all participants.

Esperanto is such a language and is being used internationally in several ways of which I will mention three:—

(1) "*Scientific Studies*" based on original research and observations (this is the translated title), edited by Paul Neergaard (Copenhagen), was published by the International Scientific Association of Esperantists, 1958, and 36 contributors of various nationalities wrote direct in Esperanto.

(2) "*Ingegneria Meccanica*" (technical journal published in Milan, Italy) is written principally for Italian engineers but also contains polylingual summaries of each article—Esperanto being one of the languages.

(3) Gevaert Photo-Production, N.V. Antwerp. This Belgian firm of film and camera makers is advertising in Esperanto, having produced brochures giving advice to camera enthusiasts together with an exposure table.

Of these three uses, the first two provide for the rapid exchange of technical information and have the additional merit of fulfilling the needs of engineers at a minimum of expense.

K. MCLENNAN, B.Sc.

Exeter

[It was never suggested that Russian should become the "diplomatic language of engineering", but merely that engineers who wish to be informed as to what is being published in Russian technical journals and books should equip themselves to read them. If and when Russian technical literature is written in, or translated into, Esperanto on a substantial scale, no doubt it will be preferable to learn the latter language.—ED.]

Developments in Machine Tool Control

(*Continued from page* 1391)

the invention tends to be condemned rather than the choice of application."

Once the full implications of what has already been accomplished—or is likely soon to be accomplished—in the field of control have been accepted and acted upon, many changes in design may be anticipated. These changes, moreover, will not necessarily be confined to the introduction of virtually frictionless slideways and nuts, but may often be of a fundamental nature. Ability to superimpose accuracy electronically will free designers from many restrictions under which they have laboured hitherto, and they, in turn, must free themselves of all preconceptions as to what something ought to look like if it is to "look right."

News of the Industry

Calder Valley

HENRY BROADBENT, LTD., Sowerby Bridge, have orders in hand for vertical boring and turning mills of 5-, 6-, 8-, and 10-ft. diameter capacities, two of the largest machines being destined for the U.S.A. Standard lathes in progress include 8½-, 10½-, 12½-, and 14½-in. centre machines, and among the larger-size lathes recently ordered, we may note three 18/20-in. centre break lathes and a 44-in. centre crankshaft-turning lathe.

RUSHWORTH & CO. (SOWERBY BRIDGE), LTD., Sowerby Bridge, have a good order book for plate-working machinery for customers both at home and abroad. Work in progress includes medium-size, single- and double-ended, punching, shearing and angle cropping machines; medium-size guillotine shearing machines; plate bending rolls, of various sizes, up to 8-ft. by 1¾-in. and 10-ft. by 1-in.; and three sizes of scrap shearing machines. Export markets include India, Australia, South Africa, and Canada.

❖ ❖ ❖

Mr. E. Cassleton Elliott, C.B.E., F.C.A., who became a director in 1937, and has thus completed 21 years' service, during the last five of which he has been chairman of the Kerry Group of Companies, was recently entertained at a complimentary luncheon by his colleagues on the board of Kerry's (Great Britain), Ltd. He was presented with a silver salver, inscribed and autographed, in recognition of his valued services, and as a token of their esteem. The photograph shows (left to right) Mr. R. Gresham Cooke, C.B.E., M.P., Mr. W. N. Hart (managing director), Mr. R. J. Lewis, Mr. E. Cassleton Elliott, Mr. H. R. Peters, and Mr. W. Hart

SWIFT-SUMMERSKILL, LTD., Sowerby Bridge, are occupied with the production of planing machines, which include double-housing types from 3 ft. 6 in. to 7 ft. wide, and openside types from 2 to 4 ft. wide. In the export field we may note business with South Africa, Australia, India, Pakistan, and Aden.

JAMES BEDFORD & CO. (HALIFAX), LTD., Sowerby Bridge, are busy on orders for steel factory equipment, comprising adjustable shelving, storage bins, stacking trays, workshop benches, and tool cabinets. We may note recent orders from the Burmese Government for steel shelving, and other customers include the British Aluminium Co., Ltd., and various American companies with factories in Scotland and the Midlands. There is a steady demand for the firm's mobile inspection unit, and for the larger range of tool cabinets now available. Additional electric welding equipment has recently been installed.

SIMILEX MANUFACTURING CO., LTD., Sowerby Bridge, are producing their ranges of Slik standard and special T-bolts and T-nuts, forged steel clamps, and square-hole spanners for toolpost screws, in addition to all-steel welded swarf and flat-topped trucks. Our attention was drawn to a recently-developed motorized contour shearing machine, which has a capacity for sheets up to $\frac{3}{4}$ in. thick. We hope to make further reference to this machine in due course.

SANDHOLME IRON CO., LTD., Todmorden, have a variety of products in hand for installation in power plants, collieries, and colliery by-products plants, also iron ore sintering equipment. On the foundry side, there is a steadily maintained demand for spheroidal-graphite, Ni-resist, and grey-iron castings. S.G. iron castings of high tensile strength can be supplied. Recently-installed equipment enables heat-treatment operations of all kinds to be carried out.

A. KINGHORN & CO., LTD., Todmorden, have recently noted an expansion in the demand for press brakes and sizes now in hand range

from 30 tons by 4 ft., up to 200 tons by 8 ft. When required, these machines can be fitted with two-speed gearboxes. Other work in progress includes guillotine shearing machines from 6 and 8 ft. by ⅛ in. up to 8 ft. by ¾ in., also hand lever shearing machines, and special tooling equipment for bending operations on press brakes. South Africa and India are the principal export markets.

JOHN PICKLES & SON (ENGINEERS), LTD., Hebden Bridge, have a wide variety of woodworking machinery on order, about half of which is destined for abroad. In the works we noted, in progress, in addition to the standard types for joiners, pattern-makers and cabinet-makers, 2- and 3-drum sanding machines, rotary veneer peelers, a motorized 15- by 6-in. 6-cutter planing and moulding machine for India, single- and double-ended tenoning machines, flat veneer slicers with Ward-Leonard drives, a high-speed vertical log frame, wood wool machines, glue jointers, and automatic saw sharpeners. On overseas account we may mention machines destined for India, Pakistan, Australia, U.S.A., Iraq, Nigeria, Ghana and Tanganyika. The latest addition to plant is a Dean, Smith & Grace 17-in. swing centre lathe. Extensions are in progress to the stores and cloakroom accommodation at the works.

ORMEROD SHAPERS, LTD., Hebden Bridge, report a steadily maintained demand for pillar-type shaping machines ranging from 10 to 36 in. stroke, single- and double-head traversing-type shapers from 16 to 32 in. stroke, and slotting machines from 4 to 20 in. stroke. Overseas destinations for some of these machines include South Africa, India, Pakistan, Canada, Australia and Indonesia. Other activities include the production of machine shop accessories and equipment, such as surface plates, marking-out tables, angle-plates, steady rests, and machine vices.

P. CROSSLEY, LTD., Mytholmroyd, report a regular demand for turned hexagon-head bolts and screws in sizes from 2 B.A., up to ¾ in. diameter by 2½ in. long, with all forms of threads. To enable production to be increased, a Maiden bar chamfering machine, and another Gridley automatic for second-operation work, have been added to the plant.

SAGAR-RICHARDS, LTD., Luddendenfoot, are well employed with the production of die cast aluminium-bronze synchromesh gear components and gear selector forks, for the motor car, motor vehicle and tractor industries, also aluminium and zinc alloy die castings. Other products include aluminium-bronze centrifugal castings, which are being supplied in bush form, fully machined, in sizes up to 12 in. diameter by 12 in. long. The recently-built machine shop is now in full operation.

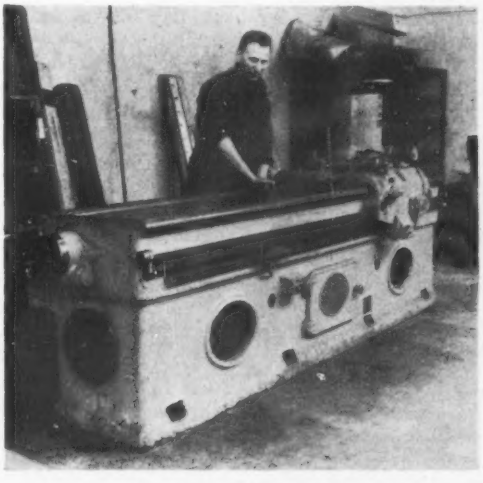
C. LINDLEY & CO., LTD., Luddendenfoot (head office—34 Englefield Road, London, N.1), state that the call for bolts, screws, studs, nuts and other repetition cold-formed products is maintained at a good level, from the motor car, motor vehicle, tractor, aircraft, electrical engineering, oil refining, general engineering, and machine tool industries.

H. B.

The West

GODWIN, WARREN & CO., LTD., 117/123 Redcliffe Street, Bristol, are experiencing a good demand for a wide range of steels, large stocks of which are maintained in their extensive warehouses. Flat, round, square, and other sections are available for early delivery over a large area of Southern, Western, and Central England. Engineers' small tools are also distributed by this company which, it may be noted, is a member of the Miles Druce Group.

S. VEALS & SON, Tower Hill, Bristol, 2, have recently installed a 6-ft. capacity Thos. White automatic blade grinding machine in their Easton Road shops where facilities are available for servicing a wide variety of shear blades and other edge tools used in many industries. Established in Bristol for more than 100 years, this company



Thos. White automatic blade grinding machine installed in the works of S. Veals & Son, Bristol

has specialized in blade grinding during much of this period and work is undertaken for users of guillotines and shearing machines over a considerable area.

In the Bristol region, it is stated, blades are normally collected, serviced and delivered within two days. Special arrangements are made for emergency repairs. The machine, illustrated on page 1439, enables bevelled and hollow or flat ground knife edges to be produced.

THE HORSTMANN GEAR CO., LTD., Newbridge Works, Bath, are still busy with the production of screw and plain type plug and ring gauges, to recognized standards of accuracy. Sales of these products in the home market are maintained at a satisfactory level, and export trade is reported to be increasing. It may be noted, for example, that a valuable order was recently secured for gauges for delivery to India.

The Horstmann Mk. II time switch, operated from a mains supply, but provided with a reserve spring which becomes effective in the event of power failure, is in growing demand. It is used extensively for controlling equipment operated during off-peak periods, when reduced tariffs for current supply are in force.

B. & B. PRESSINGS, LTD., Tewkesbury Road, Cheltenham, are engaged in the production of a range of pressings to which various finishes are applied, including cadmium and chromium plating, and stoved coatings. This firm also makes single stage and follow-on press tools for the electrical trade and for other branches of industry. Improved facilities for heat treatment operations are to be provided in the near future.

Additional machine tools, including an H.M.E. 40-ton press, a sheet metal folding machine, and a guillotine, have been installed during the past year.

PRECISION PRODUCTS (CHELTENHAM), LTD., Cheltenham, are occupied with the production of hydraulic cylinders of many sizes for medium and high operating pressures. To facilitate honing the cylinders, equipment specially designed for this purpose, is shortly to be installed. The production of press tools is also undertaken by the company and for this purpose two Newall jig boring machines and other precision equipment are available.

R. F. COMPONENTS (CHELTENHAM), LTD., 17 Lansdown Place Lane, Cheltenham, are still busy with contract work and the construction of special equipment for various firms. The facilities offered by this company have recently been increased by the installation of a Sparcatron Mk. III, 6·5-kW., spark erosion machine which can be employed, for example, for producing plain or profiled slots, holes or cavities in any metal, irrespective of its hardness. At present, this equipment is being used for producing patterns of slots in certain areas of long heating cylinders for injection moulding machines. The cylinders are fully heat treated before the slots are formed. The Sparcatron equipment is also to be used for producing a number of accurately-positioned square holes in a hardened steel component, the machining of which by other means would present considerable difficulty.

L. J. H. BALLINGER, LTD., Station Road, Woodchester, Stroud, Glos., are engaged in the design and construction of abrasive wheel cutting-off machines which are used extensively for a wide range of materials, including titanium, beryllium, high nickel alloys such as are used for gas turbine blades, chilled iron, magnetic alloys and spring steels. This firm has specialized for a considerable period in cutting with abrasive discs, and the standard range of machines provides for operations on small or large sections, with or without coolant.

Among the special machines recently produced is one of unusual size, with base dimensions of 20 ft. by 12 ft. Fitted with a 30-in. diameter abrasive wheel driven by a 30-h.p. motor, it will cut ingots and billets of the toughest alloys so far introduced. The billet is hydraulically clamped on a strengthened table, and the wheel-head has power feed for cutting at the rate of 1 sq. in. per 8 sec. A similar machine with larger overall dimensions, and increased cutting capacity, is on order.

Another machine, intended for removing risers and runners from gas turbine blades produced by investment casting, is so designed that the abrasive wheel is moved in an arcuate path. The movement is imparted to the wheel-head by an air cylinder, and an indexing table, with sets of air-operated gripper fingers for clamping the work, is provided. A standard Ballinger type A cutting-off machine has been fitted with a feeding mechanism which enables 10 heat-treated alloy steel rods to be advanced against a stop, and simultaneously cut off to a length tolerance of $+0\ -0{\cdot}005$ in. an output of 10,000 pieces per day being maintained.

F. W. H.

British Metal Sinterings Association

The formation of the British Metal Sinterings Association was announced recently at a reception given at the premises of the Federation of British Industries, 21 Tothill Street, London, S.W.1.

Founder members of the association include Bound Brook Bearings, Ltd., Lichfield, Staffs.; The Manganese Bronze & Brass Co., Ltd., Ipswich,

Suffolk; Metal & Plastics Components, Ltd., Birmingham 11; The Morgan Crucible Co., Ltd., London, S.W.18; John Rigby & Sons, Ltd., Cleckheaton, Yorks.; Sintered Metal Components (Chard), Ltd., Chard, Somerset; and Sintered Products, Ltd., Sutton-in-Ashfield, Notts. Mr. E. Robson, managing director of the Manganese Bronze & Brass Co., Ltd., has accepted the office of chairman, and the secretaries are Peat, Marwick, Mitchell & Co., Beaufort House, Newhall Street, Birmingham 3, to whom enquiries should be addressed.

The association will place at the service of industry the combined experience of its members in the field of powder metallurgy. Enquiries received by the secretaries will be passed to all member firms, and in this way those with the greatest experience in particular fields will be given the opportunity of proposing the best solutions to individual problems.

A well-produced 32-page brochure entitled "Metal Sinterings—A Guide to their Application in Industry" has been issued by the Association, and copies may be obtained on application to the secretaries at the above address.

A variety of sintered metal components that have been produced by member companies is illustrated in the brochure, and accompanying diagrams give important dimensions, and the tolerances to which they are held. The various stages in the production of powered metal parts are explained, and some of the advantages afforded by the process are discussed. Other aspects which are considered under separate headings include the design of components, compacting tools, and lubricants for impregnated parts.

This IBM Ramac (random access method of accounting and control) computer has been installed in the Renton, Washington, plant of the Transport Division of the Boeing Airplane Co., to handle orders for spare parts. When a card is fed into the intake the computer immediately checks whether the particular part is in stock and whether it is the one required for the specified aircraft. In addition, the price is verified, and an acknowledgement to the customer, shipping instructions, and—for an overseas order—an invoice, are prepared. Finally, all records are brought up to date. If an incorrect part is requested, or some other discrepancy detected, an exception card is issued. The "memory" section comprises 50 magnetic metal discs as seen on the left. On each disc face there are 100 recording tracks, and each track provides five 100-digit message areas. Essential data on some 50,000 items can therefore be recorded

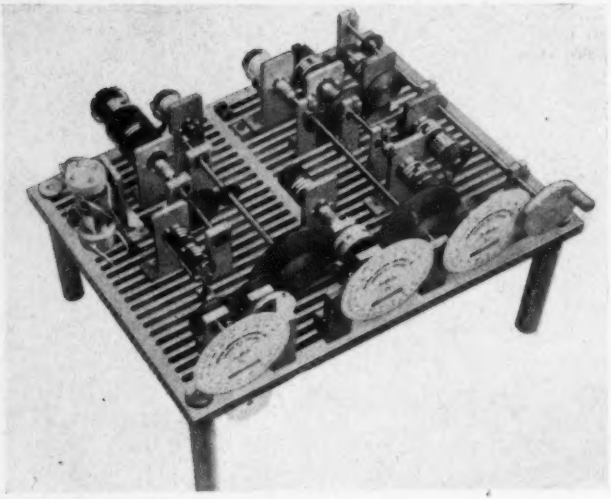
❖ ❖ ❖

Vactric Showrooms and Offices

Vactric, Ltd., have built new offices and showrooms at 207 Sloane Street, London, S.W.1, which were officially opened recently by the Rt. Hon. Aubrey Jones, M.P., Minister of Supply. The building, of five storeys, is of advanced architectural design, and is stated to be the first office block in London to be wholly air conditioned. Extensive amenities for the staff include a garage for cars in the basement.

The company was established more than 30 years ago, and in addition to the manufacture of the now well-established electric washing machines, vacuum cleaners and other domestic appliances, an important activity for some time has been the design and production of electrical servo-control equipment of very high precision. Details of some of the interesting production methods employed by Vactric (Control Equipment), Ltd., at their Acton works were published in MACHINERY, 90/452—1/3/57, and another company in the group, Vactric (Precision Tools), Ltd., Cricklewood, has up-to-date tool-room facilities for the supply of jigs, fixtures and gauges. Contract work to very close limits of accuracy is also undertaken.

Among the items displayed in the new showrooms is the installation here illustrated, which shows how the company's "breadboard" standardized servo-components are employed. These components were introduced to enable servo-systems



An application of the Vactric " breadboard " system for building-up servo-trains for demonstration and development purposes

to be rapidly built up for demonstration and development purposes, without the need for designing and making parts for the purpose. Standard components available include two sizes of slotted, light-alloy base plates, measuring 14 by 17¾ in., and 9 by 14 in., shaft supports, shafts, gears, differential units, couplings, speed reducers, adjustable cams, protractors, and terminal blocks, and the system is designed to take servo-motors of the various international frame sizes that have been standardized.

C.I.B.A. Fellowship Trust

With the object of increasing and fostering the exchange of ideas between scientists in the United Kingdom and on the Continent, the CIBA Group of companies has recently founded the CIBA Fellowship Trust, for which the trustees are Sir Arthur Vere Harvey, C.B.E., M.P., Lord Hives, C.H., and Professor Sir Alexander R. Todd, F.R.S. Several fellowships will be awarded for studies at Continental universities or institutions for research in chemistry, physics, or allied subjects, during the academic year 1959/60. Those eligible for a fellowship include graduates of universities in the United Kingdom and Northern Ireland, also in Eire, and those who will graduate this year.

It is anticipated that some Fellowships will be granted to recent graduates, and others will be awarded to those who have already taken their Ph.D., or who have spent some time in industry. Full details of the Trust, and the monetary values and terms of the awards, can be obtained on application to The Secretary, CIBA Fellowship Trust, CIBA (A.R.L.), Ltd., Duxford, Cambridge.

British Machinery Merchants

Following a conference on November 4, at which it was decided to form an organization with the provisional title of The Association of British Machinery Merchants, the committee then appointed, under the presidency of Mr. Harold Vernon, has met, and various decisions have been reached. Membership is to be open to machinery merchant firms which hold stocks and have their own facilities for repair and reconditioning, and terms of reference have been agreed whereby the objects of the Association and the scope of its activities are outlined.

Full particulars can be obtained from the secretary, Mr. C. W. Allen, 100 Park Street, Grosvenor Square, London, W.1.

Brookhirst Igranic, Ltd.

A new company, Brookhirst Igranic, Ltd., has been formed to bring under one management the two electrical subsidiaries of Metal Industries, Ltd., namely Brookhirst Switchgear, Ltd., Chester, and Igranic Electric Co., Ltd., Bedford. The board of the new company comprises Sir Charles Westlake (chairman), Mr. John Black (deputy chairman), Mr. H. Owen Houchen (managing director), Mr. J. O. Knowles, and Mr. W. Padley. In a special edition of the *MI News* which has been issued in connection with the link-up, Mr. Houchen points out that the closer association of the two companies will strengthen the sales, technical, and research facilities, and will enable progress to be accelerated. Mr. D. W. Kent will continue to hold the position of general manager of Igranic, and Mr. R. H. Mercer will be general manager of Brookhirst.

Brief histories of the companies are given in the publication mentioned above. Brookhirst was founded in 1898 for the manufacture of motor starters, and Igranic was registered as a private company in 1913.

Fraser Machine Tool Demonstration

Sidney G. Jones, Ltd., 8 Balham Hill, London, S.W.12, who are the selling agents for machine tools built by Douglas Fraser & Sons, Ltd., Arbroath, Scotland, are holding a demonstration of the company's products at the industrial showrooms of the Midlands Electricity Board, 247 Chester Street, Aston, Birmingham, 6, from January 5 to 16 inclusive.

The demonstrations will be carried out from 10 a.m. to 5 p.m. on each weekday, and the equipment will include the Fraser Endomatic range, a round table drilling machine, and various unit heads. The Endomatic machines will include an SC2 type arranged for hopper feeding, which will be shown spotfacing and centre-drilling distributor spindles; a standard SC2 type for similar operations on armature shafts; and a standard MC2 machine for milling and centre-drilling crankshafts.

Personal

MR. A. NICHOLL, 21 Aldwyn Crescent, Hazel Grove, Cheshire (telephone number, Stepping Hill, 3260), has been appointed by Dean, Smith & Grace, Ltd., Keighley, as joint direct representative with Mr. G. Blemmings, for North Wales, Cheshire, and the area northwards to Carlisle.

MR. A. MCDONALD, a charge-hand in the Units and Parts Division of the Swindon factory of Plessey Co., Ltd., has been awarded 100 guineas, under the company's suggestions scheme, for designing a fixture for drilling electrical plug and socket pins. The new fixtures, which obviate a separate drilling operation, are already in use in the production lines.

MR. ARNOLD CARR, assistant managing director of Thos. W. Ward, Ltd., has been appointed deputy chairman of that company. He joined the firm in 1915, was appointed a local director in 1931, resident London director in 1941, and assistant managing director in 1954. Mr. Carr is also on the boards of a number of companies in the Ward Group. MR. DOUGLAS F. WALTON has been elected a director of Thos. W. Ward, Ltd. He has served as a local director since 1948.

U.S. Machine Tool Exports

The following table gives the quantities and value of exports of various classes of machine tools from U.S.A. during August, 1958:—

	Number	Value $
Light duty and bench lathes	30	19,599
Engine lathes	61	209,627
Turret lathes	50	128,254
Automatic chucking and between-centre lathes	46	724,283
Automatic screw machines	8	87,030
Other lathes	9	46,648
Vertical boring and turning mills, and vertical turret lathes	9	410,201
Fine boring machines, precision metal working	28	188,541
Tapping and threading machines	78	115,513
Milling machines	62	332,008
Profiling, duplicating and diesinking machines (milling type)	27	297,138
Gear cutting machines	19	138,872
Gear grinding and finishing machines	36	609,343
Drilling machines	276	379,740
Planing, shaping and slotting machines	19	180,834
Surface grinding machines	38	172,577
Tool and cutter grinding machines	50	168,993
Other grinding machines	569	1,766,503
Sawing and cutting-off machines	48	171,154
Honing and lapping machines	31	50,872
Broaching machines	7	102,467
Hydraulic presses	54	602,933
Mechanical presses	68	1,065,980
Bending and roll forming machines	206	763,984
Punching and shearing machines	71	259,290
Forging machines and hammers	27	489,512
Other machines	102	763,663

Industrial Notes

UNITED DOMINIONS TRUST, LTD., have opened a new branch office at 84-85 High Street, Chelmsford (telephone number, Chelmsford 51561-2).

FALCON TOOLS (HAMPTON), LTD., have moved to new and larger factory premises at Falcon Works, 31 Hanworth Road, Sunbury-on-Thames, Middlesex (telephone number, Sunbury 2400/2466).

MACHINE TOOLS ORDERS placed during September were valued at £4,066,000 (including £1,047,000 for export). Deliveries during the month totalled £7,246,000, of which £1,893,000 was for export. At the end of September the value of orders in hand was £59,964,000 (including £15,514,000 for export).

OUTPUT OF IRON CASTINGS.—A further decline in the output of iron castings occurred in the third quarter of this year. Production last quarter totalled 742,660 tons, compared with 887,210 tons in the previous quarter, and 846,600 tons in the corresponding quarter of last year. All the main industries which use iron castings have been taking less this year.

SINTERED PRODUCTS, LTD., Sutton-in-Ashfield, Notts., a member of the Sheepbridge Engineering Group, inform us that whereas Small & Parkes, Ltd., will continue to handle sales of the sintered friction material produced by their company, they will no longer do so on an exclusive basis. Sales will in future be under the direction of Mr. G. Wilson, sales manager of Sintered Products, Ltd., and matters relating to technical sales and development will be handled by Mr. R. I. Blackwell, of the same company, and Mr. W. Kitchen, of Small & Parkes, Ltd.

The Price of a Subscription to MACHINERY is 52 Shillings per annum, post free, to any part of the world.

Subscribers are not bound for any definite period of subscription. We send MACHINERY, post free, each week until told to stop. Subscribers can pay yearly, half-yearly, or quarterly, pro rata. (Cash with order)

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Please send me/us MACHINERY every week until I/we tell you to stop, for which I/we enclose remittance of 52 Shillings per annum or pro rata

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* For our mailing records only.

17/12/58

Machine Tool Share Market

Stock markets relapsed into quieter trading conditions during the period under review, and prices in most sections were inclined to ease with the slackening of demand, but the underlying tone remained firm.

The gilt-edged section, after suffering slight setbacks, became steadier, and at the close, price changes, on balance, were small and irregular.

In commercial and industrial share markets, conditions were mixed, with activity on a reduced scale. Early quietness gave place to a brighter trend, and by the finish there was a preponderance of modest gains.

Among machine tool issues, Clarkson Engineers advanced 7½d. to 17s. 6d.; Geo. Cohen, 3d. to 10s. 6d.; John Harper, 3d. to 16s. 9d.; Kendall & Gent, 3d. to 8s.; Kitchen & Wade, 1s. 3d. to 13s. 9d.; Modern Engineering, 1s. to 11s. 3d.; and Thos. W. Ward, 7½d. to 82s. 6d. On the other hand, Asquith Machine Tool lost 6d. at 23s. 3d.; Samuel Osborn, 6d. at 19s. 6d.; Broom & Wade, 3d. at 11s. 3d.; John Shaw & Sons (Wolverhampton), 3d. at 15s. 7½d.; Churchill Machine Tool, 10½d. at 16s. 4½d.; Craven Bros. (Manchester), 1½d. at 6s. 10½d.; F. Pratt, 1s. 3d. at 22s. 6d.; and Ambrose Shardlow, 1s. at 41s.

F. PRATT & CO., LTD.—Final dividend 24 per cent, making, with the interim, a total distribution of 36 per cent.

COVENTRY GAUGE & TOOL CO., LTD.—Final dividend 4⅜ per cent (tax free), making, with the interim, a total distribution of 6¼ per cent (tax free).

North London E.I.A. Meeting

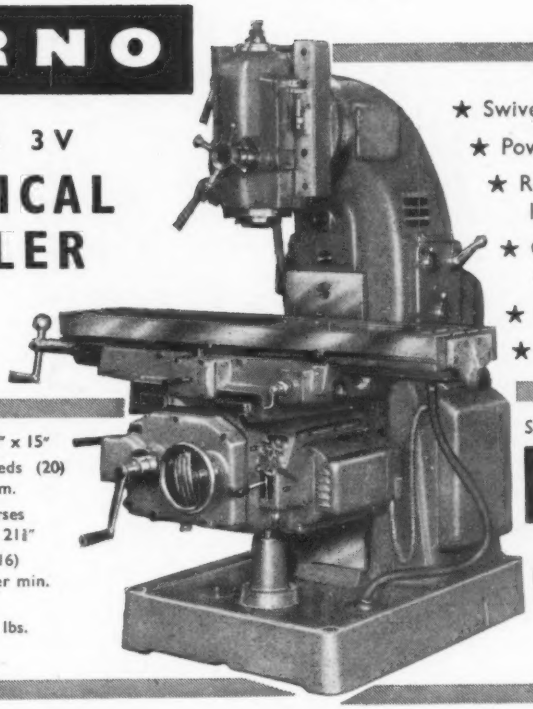
At a recent meeting of the North London Group of the Engineering Industries Association, the chairman, Mr. L. Schofield, gave a talk which was mainly concerned with the applications of spiral bevel gearing and the Klingelnberg method of producing Palloid gears. Examples of such gears, a characteristic of which is a tooth form of uniform land width, were displayed on a stand at the meeting for examination by members. It was announced during the proceedings that Lt.-Col. R. H. Rohde, the E.I.A. London Region secretary, will shortly be relinquishing his appointment after having served in that capacity for 13 years. Tributes to the work of Lt.-Col. Rohde were paid by several of the members present. Three new member firms, Uhlhorn Bros., Ltd., 51 City Road, London, E.C.1, Chromium & Anodic Finishes Ltd., 36 Ashbrook Road, London, N.19, and Automatic Products (Edgware), Ltd., 32 Sherringham Road, London, N.7, were represented at the meeting for the first time.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrongs, Stevens & Son, Ltd.	Ord.	5/-	8/9
Allen (Edgar) & Co., Ltd.	Ord.	£1	38/-
" "	5% Prf.	£1	15/6*
Arnott & Harrison, Ltd.	Ord.	4/-	15/-
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	23/3
" " "	6% Cum. Prf.	£1	18/6xd
Birmingham Small Arms Co., Ltd.	Ord.	£1	35/-
" " "	5% Cum. "A" Prf.	£1	15/3
" " "	6% Cum. "B" Prf.	£1	18/-
" "	4% 1st Mort. Deb.	Stk.	88½xd
British Oxygen Co., Ltd.	Ord.	£1	43/9
" " "	6½% Cum. Prf.	£1	21/9xd
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	4/-
Broom & Wade, Ltd.	Ord.	5/-	11/3
" "	6% Cum. Prf.	£1	17/9
Brown (David) Corporation Ltd.	5¼% Cum. Prf.	£1	15/6
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/9
Butler Machine Tools Co., Ltd.	Ord.	5/-	10/-
" " "	5% Cum. Prf.	£1	13/9xd
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	11/3
Churchill (Charles) & Co., Ltd.	Ord	2/-	6/-xd
" " "	6% Cum. Prf.	£1	26/4½
Churchill Machine Tool Co., Ltd.	Ord.	5/-	16/4½
" " "	6% Cum. Prf.	£1	18/3
Clarkson (Engrs.), Ltd.	Ord.	5/-	17/6
Cohen (George), Son & Co., Ltd.	Ord.	5/-	10/6
" " "	4½% Cum. Prf.	£1	14/6
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	18/1½
" " "	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	8/6
Craven Bros. (Manchester), Ltd.	Ord.	5/-	6/10½
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/9
" "	4½% Red. Cum. Prf.	£1	13/9
Expert Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/3
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/6
Greenwood & Batley, Ltd.	Ord.	£1	57/6
Harper (John) & Co., Ltd.	Ord.	5/-	16/9xd
" "	4½% Red. Cum. Prf.	£1	13/3
Herbert (Alfred), Ltd.	Ord.	£1	37/6
Holroyd (John) & Co. Ltd.	"A" Ord.	5/-	13/6xd
" " "	"B" Ord.	5/-	13/6xd
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/-
" " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	44/9xd
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	8/-
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	6/10½
Kitchen & Wade, Ltd.	Ord.	4/-	13/9
Martin Bros. (Machinery), Ltd.	Ord.	2/-	1/10½
Massey, B. & S., Ltd.	Ord.	5/-	9/9
Modern Engineering Machine Tools Ltd.	Ord.	5/-	11/3
Newall Engineering Co., Ltd.	Ord.	2/-	4/6
Newman Industries, Ltd.	Ord.	2/-	2/9
" "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	3/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	19/6
" " "	5½% Cum. Prf.	£1	26/-
Pratt (F.) & Co., Ltd.	Ord.	5/-	22/6
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	5/3xd
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	41/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	15/7½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	14/-xd
" " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	7/6
	"B" non-voting Ord.	10/-	22/6
Sykes (W. E.), Ltd.	Ord.	5/-	7/6
Tap & Die Corporation, Ltd.	4½% Deb. 1961-1977	Stk.	82/-
" " "	Ord.	10/-	18/9
Wadkin, Ltd.	Ord.	£1	82/6
Ward (Thos. W.), Ltd.	5% Cum. 1st Prf.	£1	16/6
" "	5% Cum. 2nd Prf.	£1	24/-
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

ARNO

TYPE 3V VERTICAL MILLER



★ Swivelling and sliding head
★ Power feeds in three directions
★ Rapid traverses with single lever control
★ Centralised grouping of control levers
★ Hardened and ground gears
★ Schlesinger limits

Table w.s. 63" x 15"
Spindle speeds (20) 30—1,200 rpm.
Power traverses 51½" x 14½" x 21½"
Table feeds (16) .281"—22" per min.
H.P. 17
Weight 7040 lbs.

Sole Agents

PIDGEN BROS
LIMITED
HELMET ROW, OLD STREET
LONDON, E.C.1.
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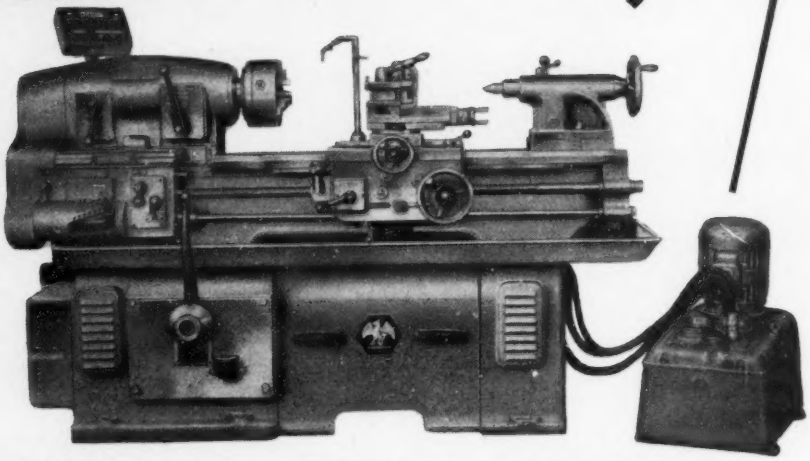

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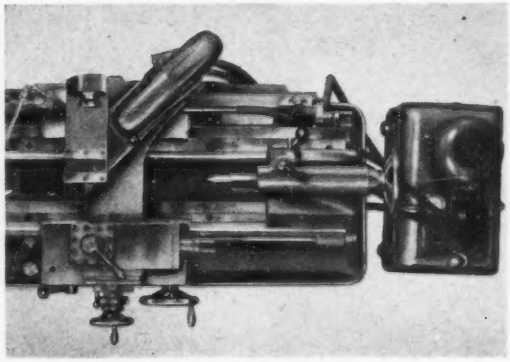

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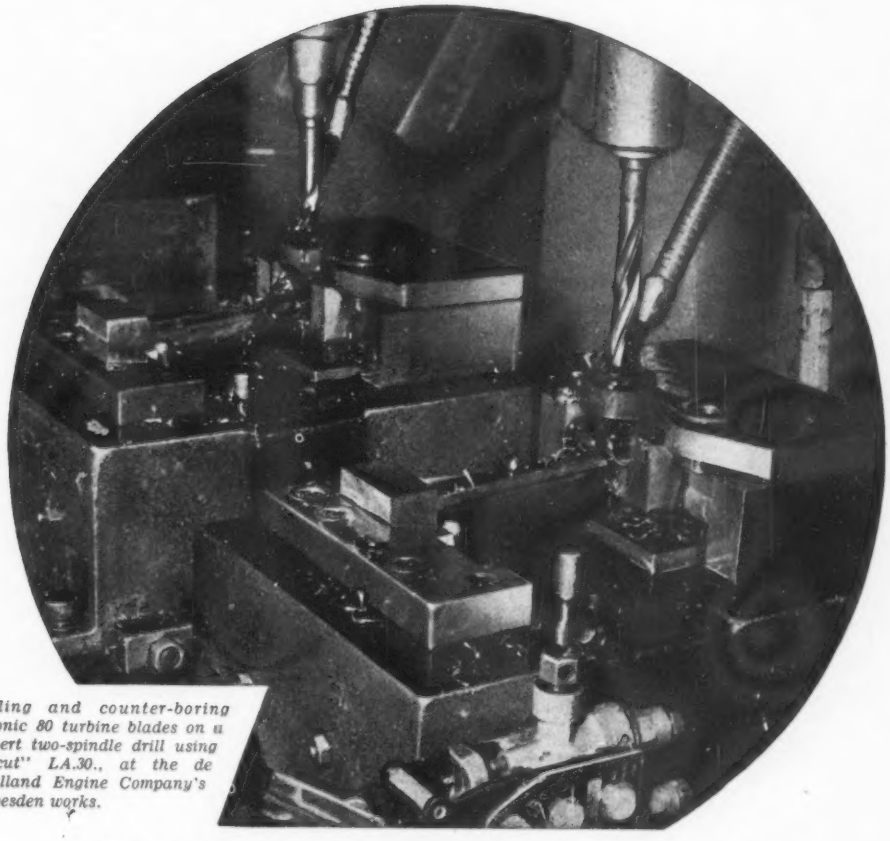

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Electrical Aids in Industry

Data Sheet **No. 4**

Resistance Heating – 1

In this form of heating, the heat is produced by passing an electric current through a high resistance conductor which is termed the "heating element".

The heat is transferred from the heating element to the work by convection, radiation or conduction or by a combination of any, or all, of these. When it is a question of radiation or convection, the element can be a bare wire or strip of suitable material, provided it is adequately supported on electrical insulation capable of withstanding the temperature.

When there is to be contact between the work and the element, heat being transferred to the work by conduction, the wire or strip must be surrounded by suitable insulating material and enclosed in a protective sheath.

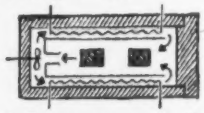
In the majority of cases, the wire or strip forming the heating element is made of a nickel-chromium alloy which has a high electrical resistance and can be safely used in air at temperatures of up to 1050°C., or in a suitable atmosphere, of up to 1150°C. Other element materials are available for use at higher temperatures.

Electric resistance heating may profitably be put to many diverse uses; two of these are described briefly below, others will be listed in a subsequent data sheet.

Furnace Heating

Electric resistance furnaces can be divided into two main categories, batch type and continuous. In most cases, the heating elements are of nickel-chromium alloy, for furnace temperatures up to around 1050°C., but higher temperatures, up to nearly 3000°C., can be obtained by using other metals or alloys, or in some cases non-metallic elements. A protective atmosphere is desirable to prolong the life of some of these higher-temperature elements. For all temperatures, electric resistance furnaces can be constructed so that the heating process takes place in a controlled atmosphere if this is dictated by the composition or heat requirements of the work charge. In some furnaces, fans are used to circulate the air or special atmosphere over the charge, thereby giving increased heating rates and a uniform temperature over the whole charge.

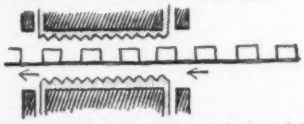
Automatic temperature control and programme control of the heating process are readily effected.



Electric furnaces are extensively used in industry, for example in the general heat treatment of metals, in the glass and ceramics industries, for brazing and sintering, and for many other applications requiring temperatures above 500°C.

Oven Heating

There are two basic forms of heat transfer used in electric resistance ovens; convection and radiation. The latter is dealt with in a separate data sheet under the heading "Infra-Red Heating".



Convection ovens may again be of the batch or continuous type. In either case, the charge is heated mainly by the movement of hot air, which is sometimes assisted, as in furnaces, by fans to give a rapid and uniform temperature rise. Ovens are normally designed for temperatures of up to about 500°C., and the heating elements are invariably of nickel-chromium or nickel-chromium-iron alloy.

Ventilation, when required, can be provided and regulated entirely to suit the heating process. Temperatures and times are readily controlled. A vacuum can be maintained in suitably designed ovens to assist in the extraction of moisture and solvent.

Convection ovens are extensively used for drying, baking and stoving operations, and for a host of other processes requiring a low or medium temperature.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, W.C.2.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available—"Induction and Dielectric Heating" is an example; "Resistance Heating" is another.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

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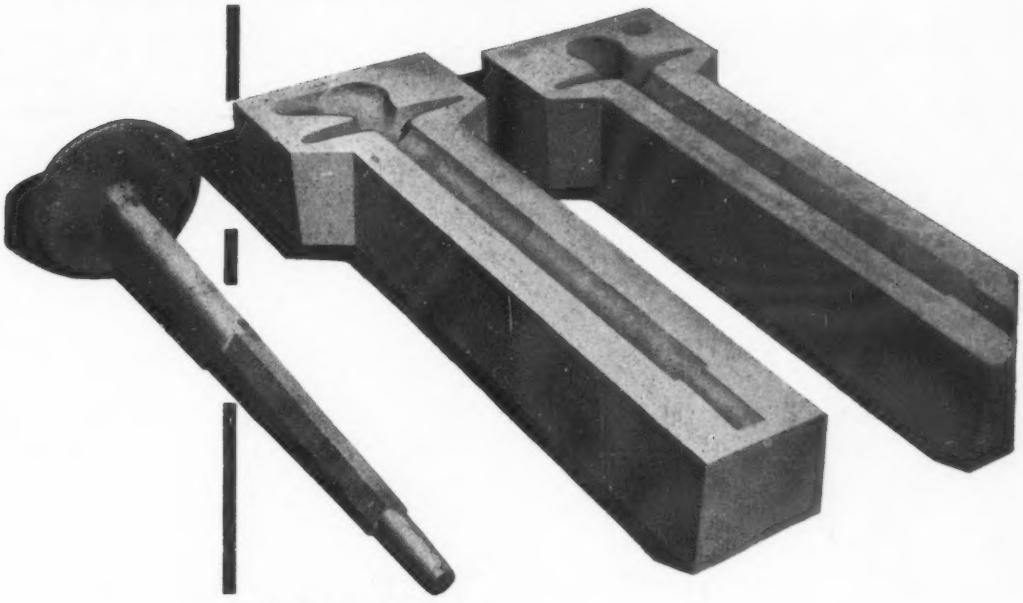

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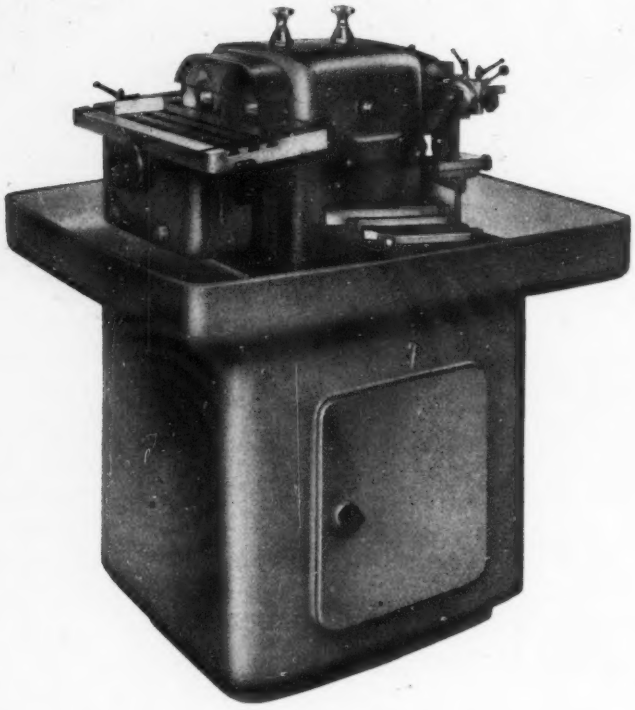

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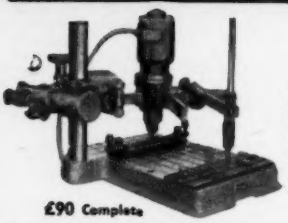

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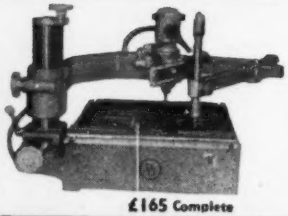

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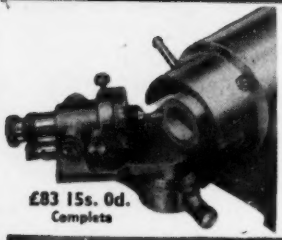

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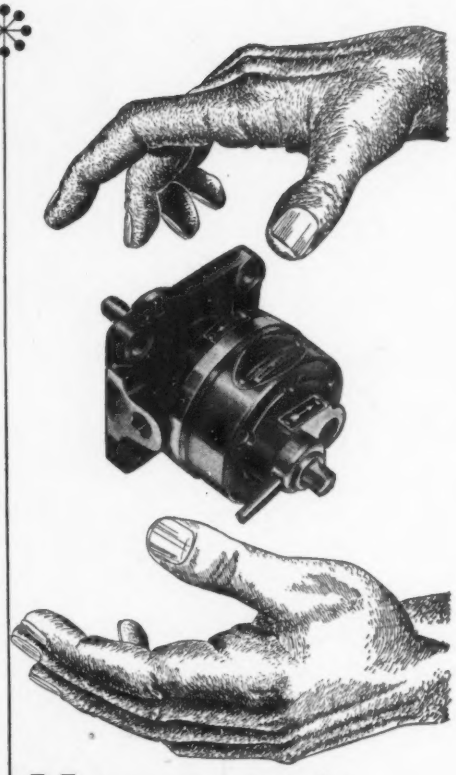

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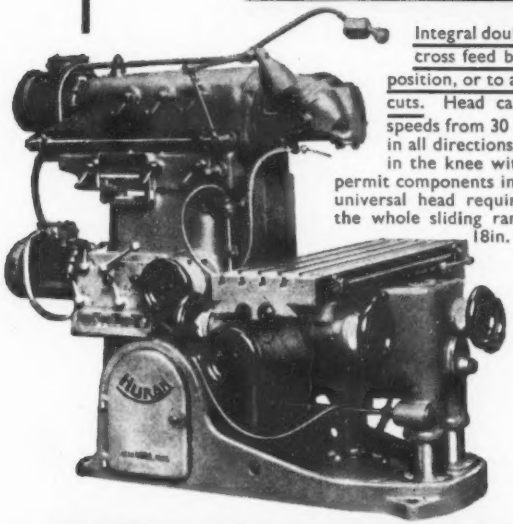

Integral double swivelling universal head provided with 27½in. automatic cross feed by the sliding ram, can be set to the horizontal or vertical position, or to any angle instantaneously—permits the heaviest production cuts. Head can be retracted completely from table line. 27 spindle speeds from 30 to 2,066 r.p.m. 27 feeds from $\frac{1}{16}$in. to 30in. Rapid traverses in all directions. All operating controls duplicated. Table slides directly in the knee without cross movement or swivel. Double guides of knee permit components in excess of 1½ tons to be machined. The double swivelling universal head requires an opening of only 14in. to enter work pieces and the whole sliding ram with its 27½in. automatic cross movement needs only 18in. clearance.

Type	Table	Automatic Feeds Long	Cross	Vert.
KU4	56$\frac{5}{16}$in. × 15$\frac{3}{4}$in.	43$\frac{1}{2}$in.	27½in.	19$\frac{3}{4}$in.
KU5	64$\frac{5}{16}$in. × 15$\frac{3}{4}$in.	51$\frac{1}{2}$in.	27½in.	19$\frac{3}{4}$in.
KU6	78$\frac{3}{4}$in. × 16$\frac{1}{2}$in.	59in.	27½in.	19$\frac{3}{4}$in.
L7	157in. × 39in.	118in.	27½in.	39$\frac{3}{4}$in.

Type 'L' Open-side Traversing Head Universal Miller will mill, bore, slot and drill the largest work-pieces at one setting.
The unique design permits greatest variety of operation on large work-pieces; the component remains stationary on the large work-table. Upright slides full length of base table, and the sliding ram moves vertically and horizontally.

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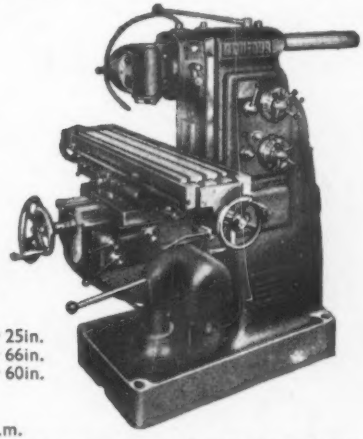

Table surface 43$\frac{5}{16}$in. by 9$\frac{7}{8}$in. or 47½in. by 10$\frac{7}{8}$in. Auto long. feed, 26$\frac{3}{4}$in. or 30$\frac{3}{4}$in. Auto vert. feed, 15$\frac{3}{4}$in. or 18$\frac{7}{8}$in. Auto cross feed 9½. Rapid traverse in all directions. No. 40 International taper for main spindle, universal head, and rotary table. Direct reading dial change for speeds and feeds. All parts subject to wear hardened and ground and completely interchangeable. Built to closest tolerances. Spindle speeds 21 to 1,600 r.p.m. Twin overarms. Separate motor for rapid traverses.

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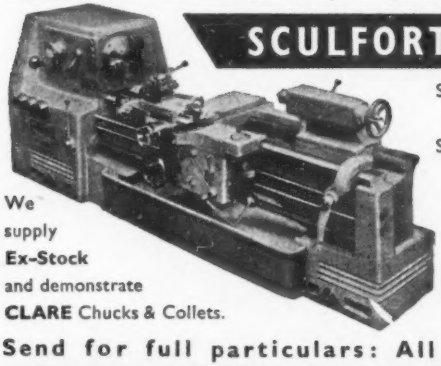

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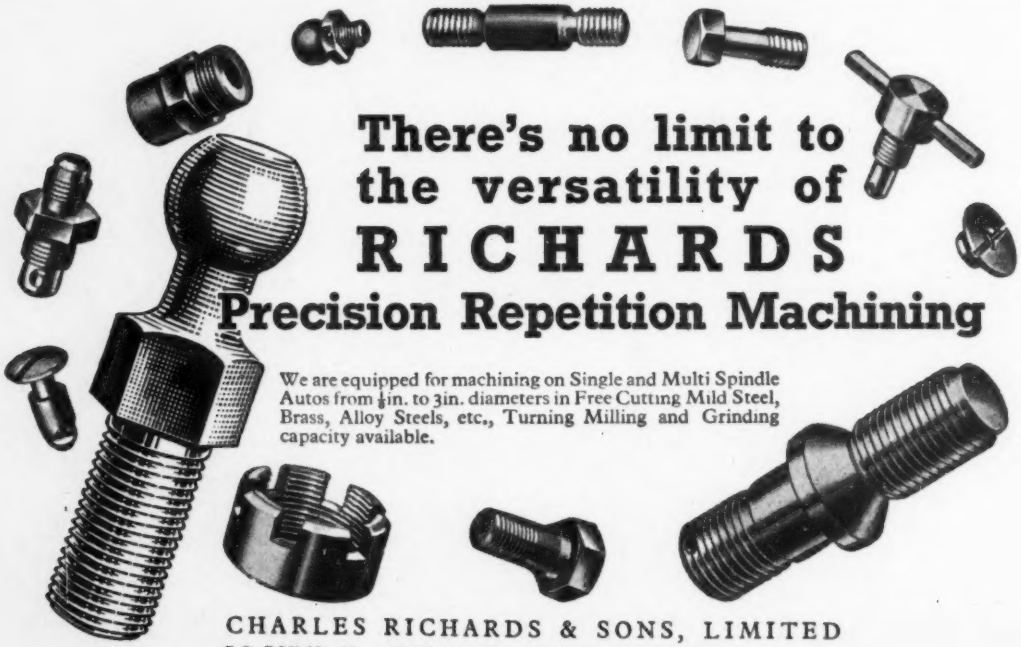

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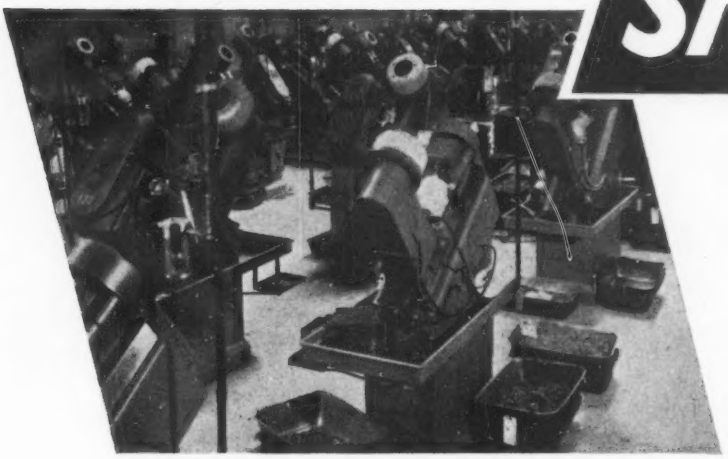

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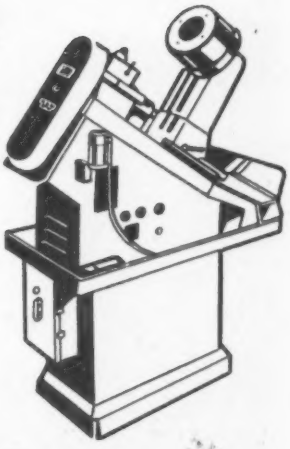

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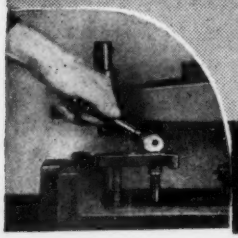

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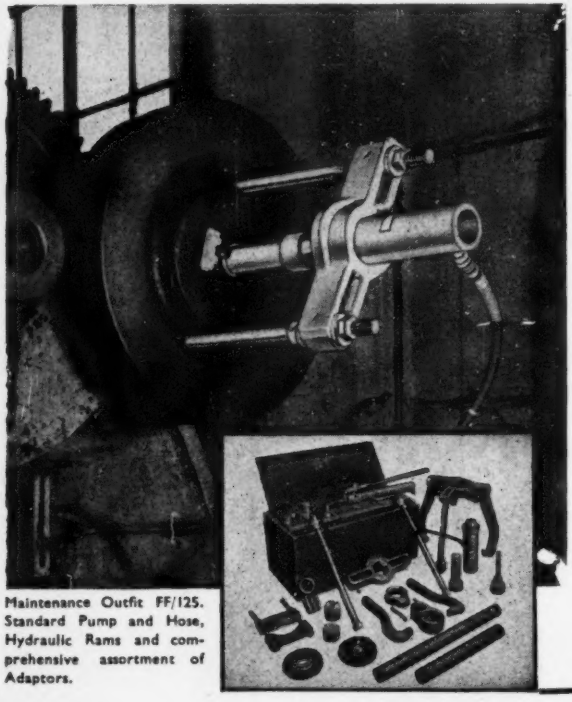

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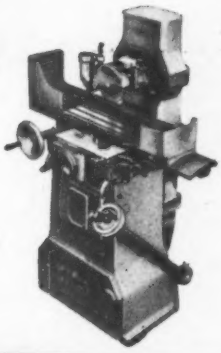

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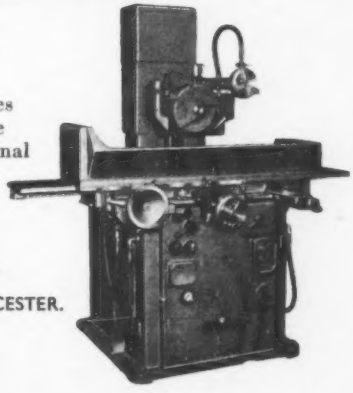

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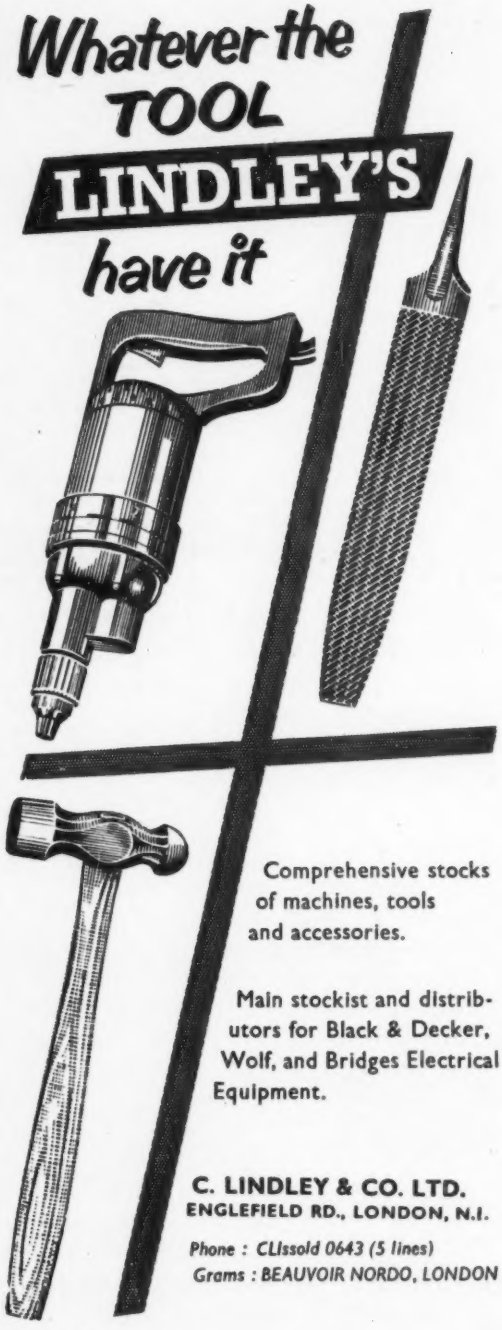

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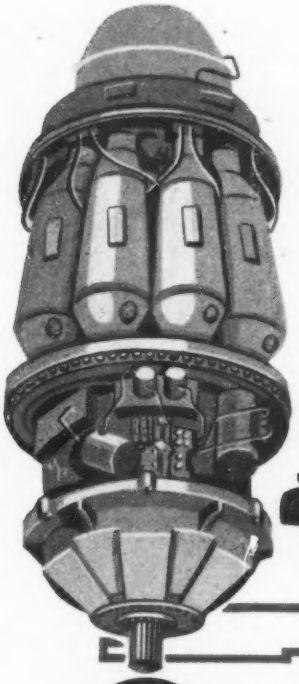

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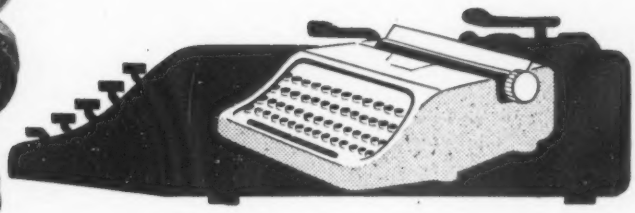

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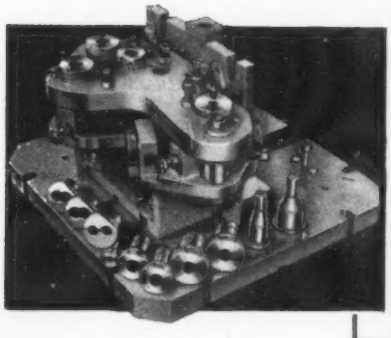

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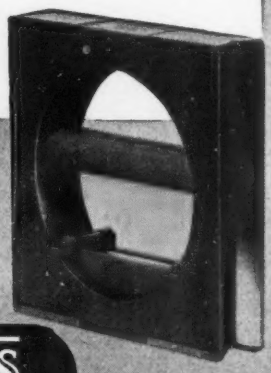

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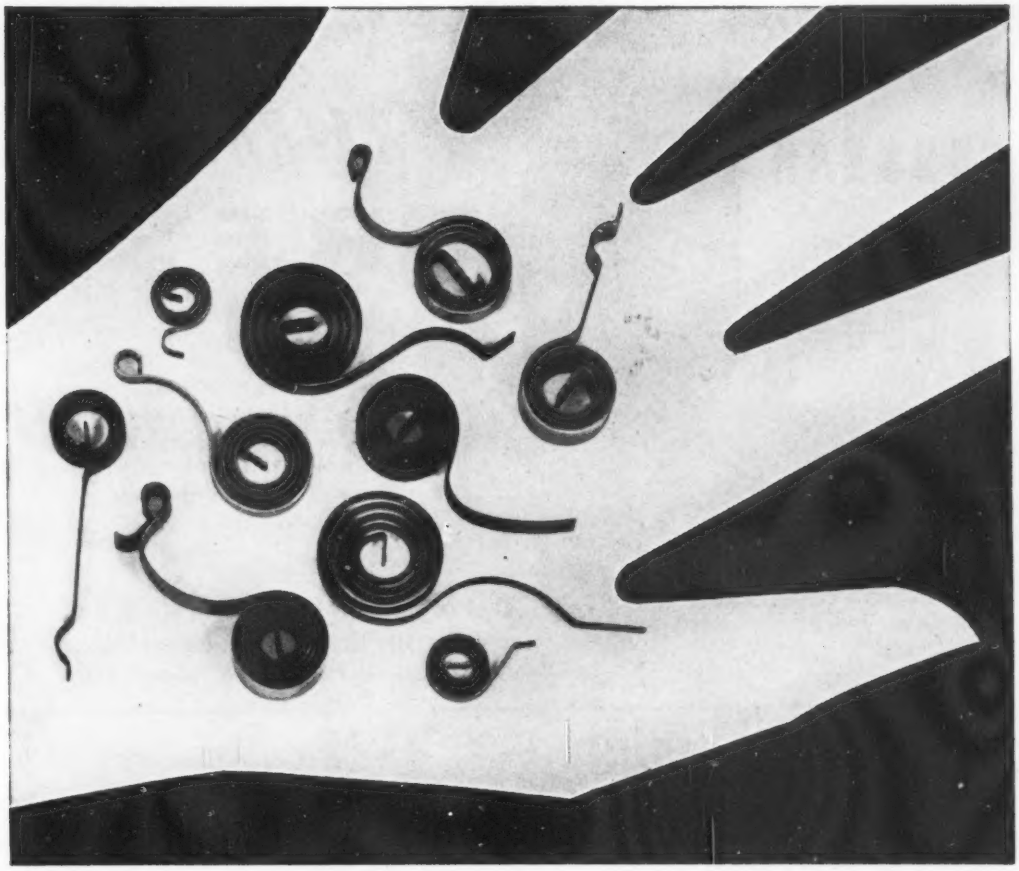

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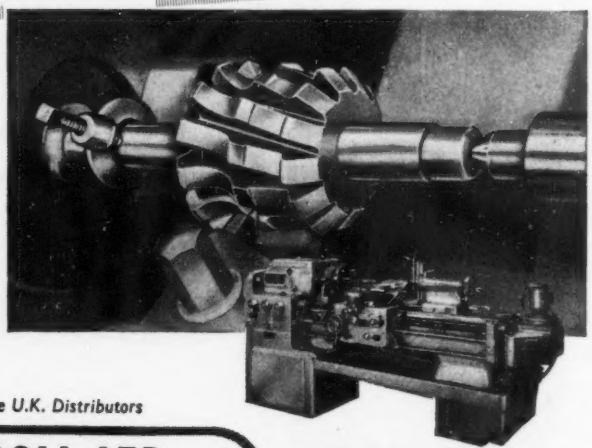

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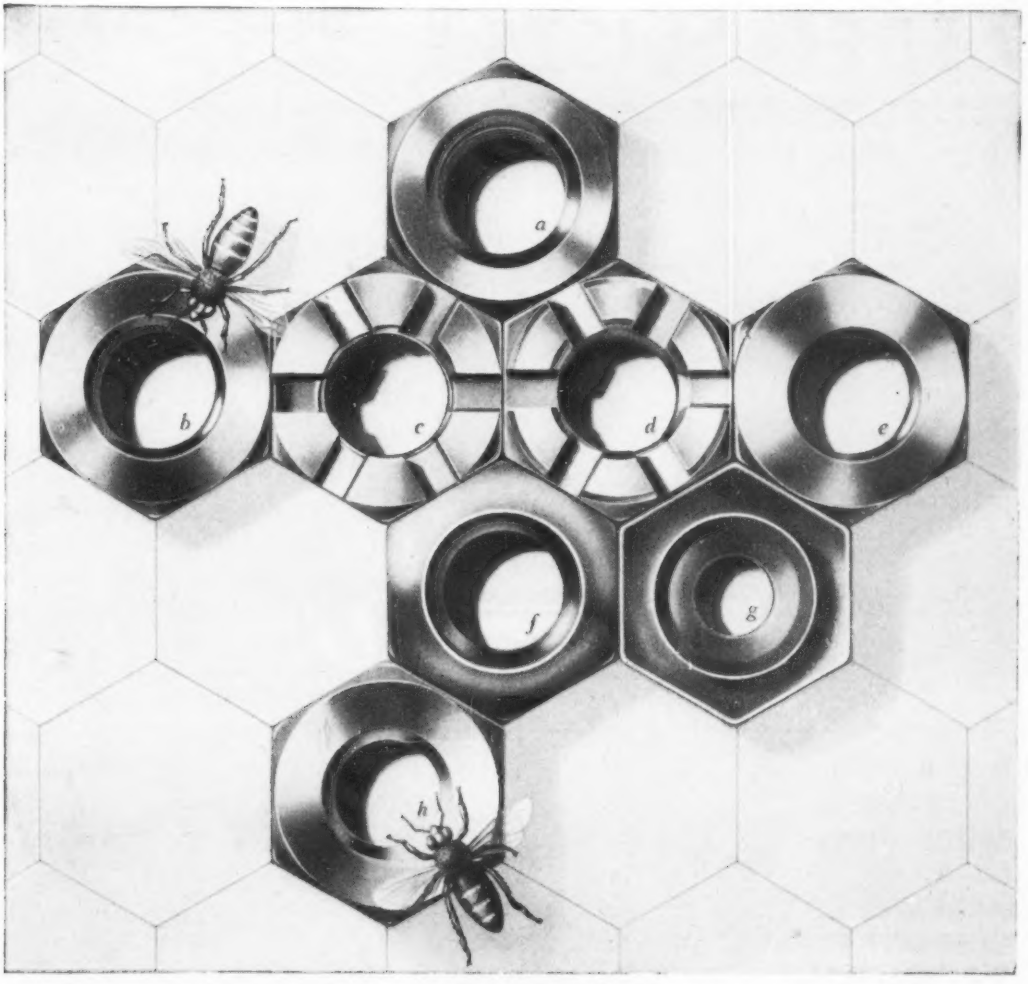

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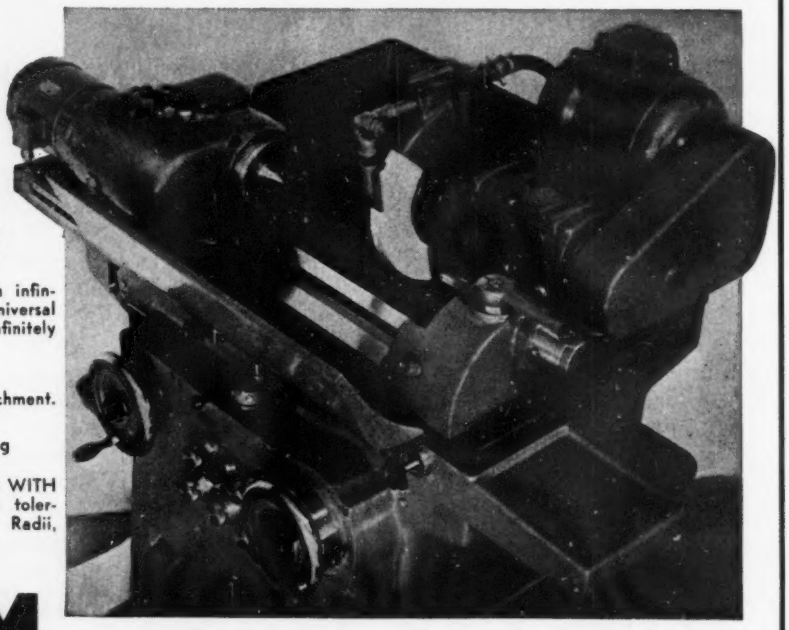

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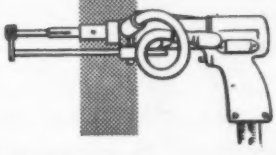

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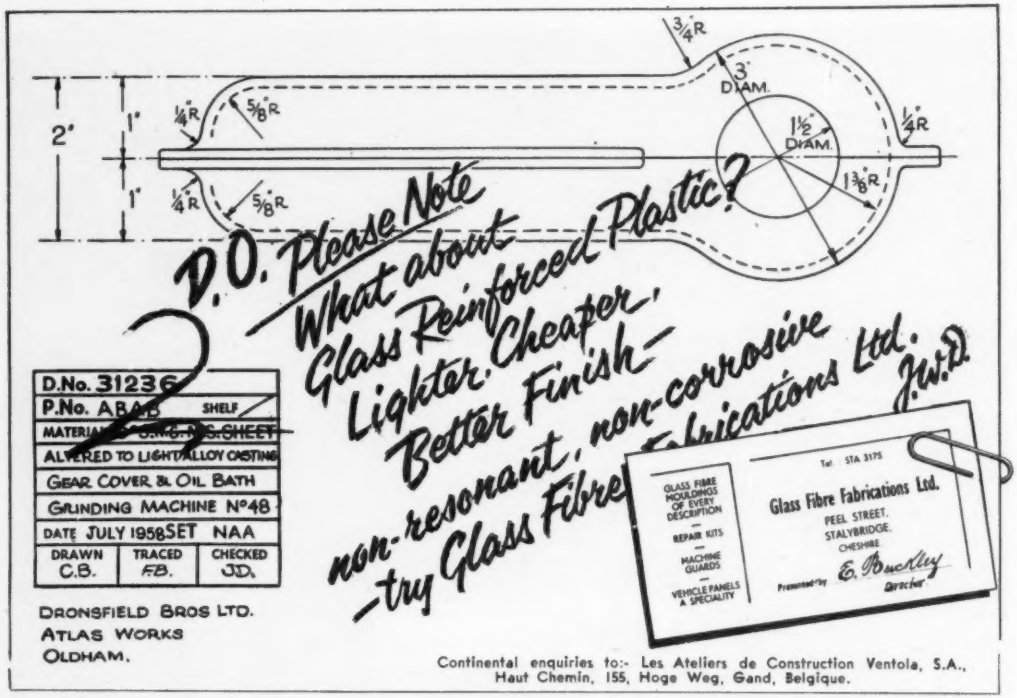

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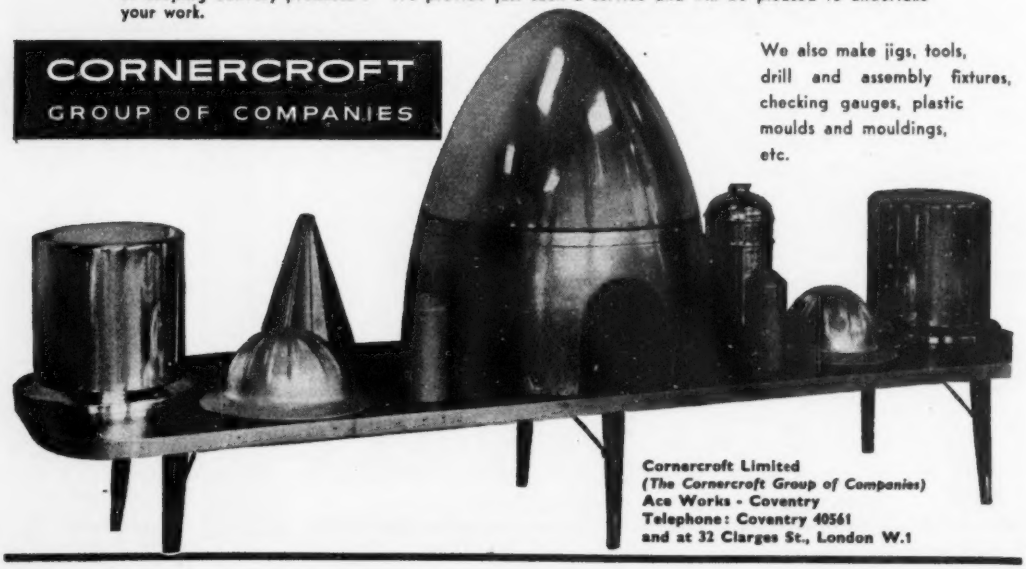

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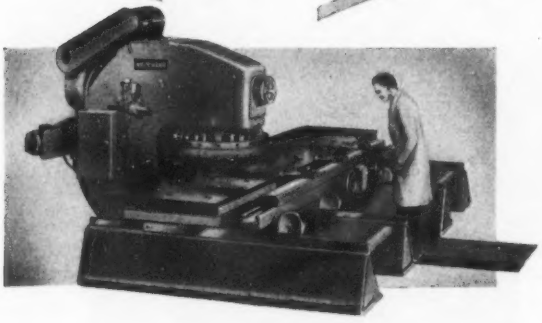

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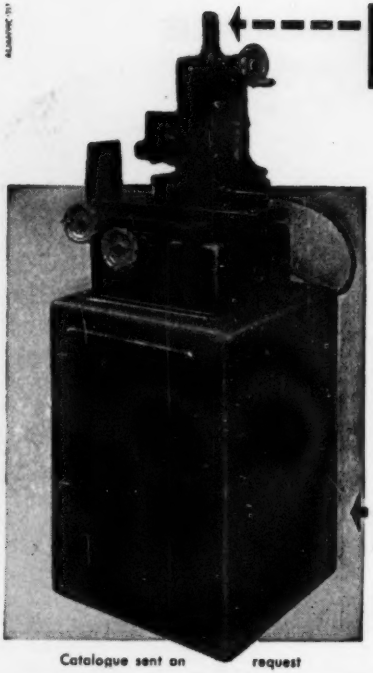

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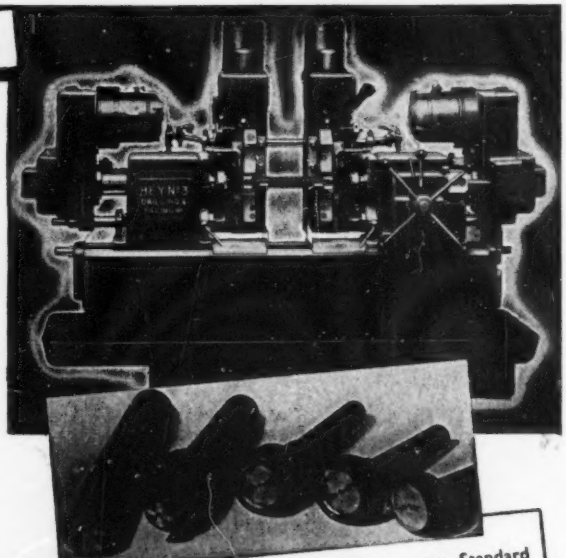

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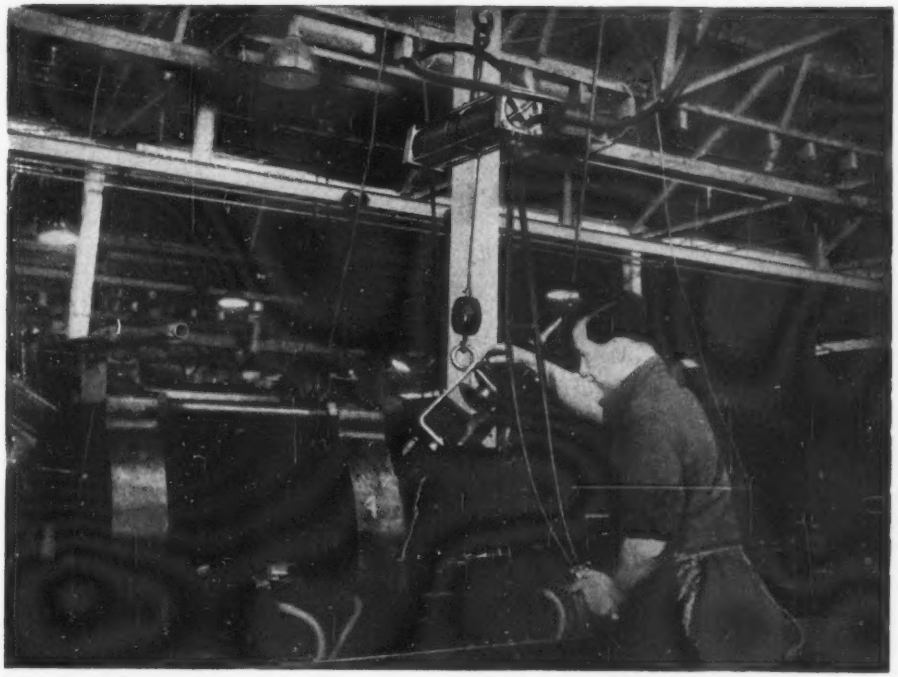

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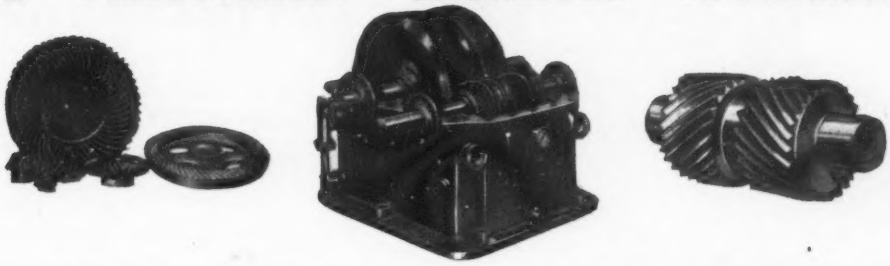

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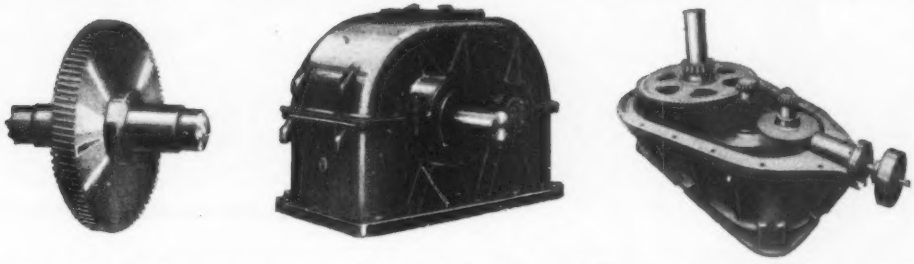

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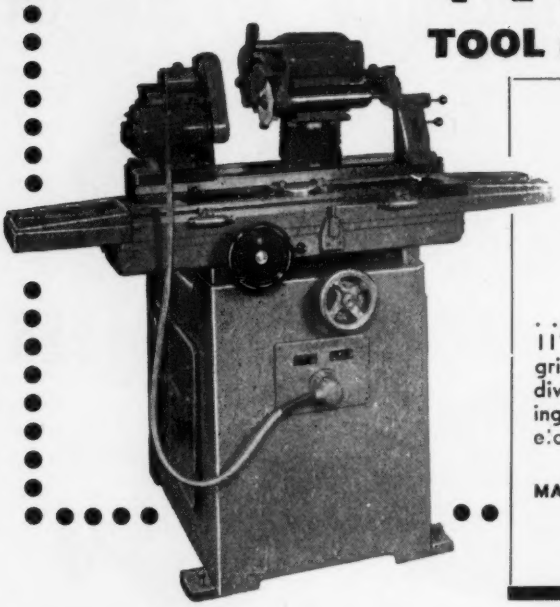

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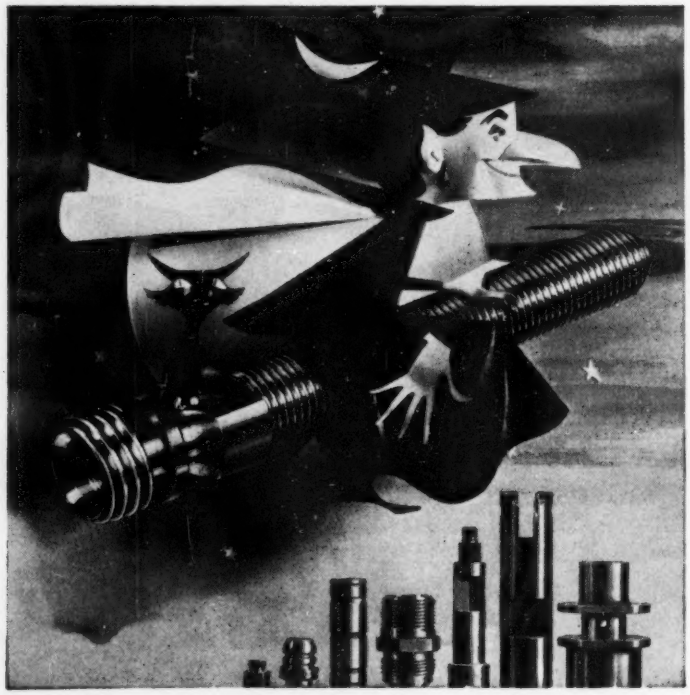

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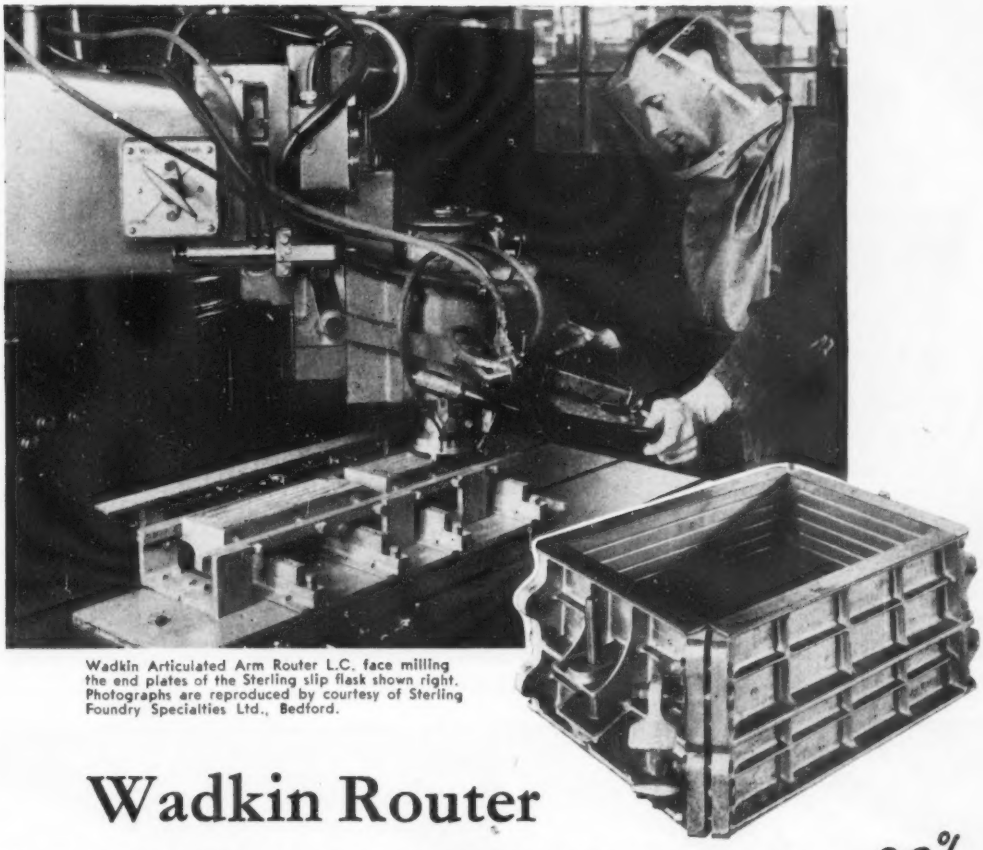

Wadkin Articulated Arm Router L.C. face milling the end plates of the Sterling slip flask shown right. Photographs are reproduced by courtesy of Sterling Foundry Specialties Ltd., Bedford.

Wadkin Router

CUTS OVER-ALL MACHINING TIME BY 80% on Sterling slip flasks

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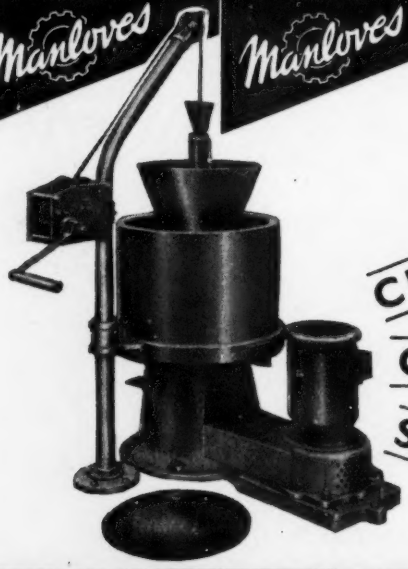

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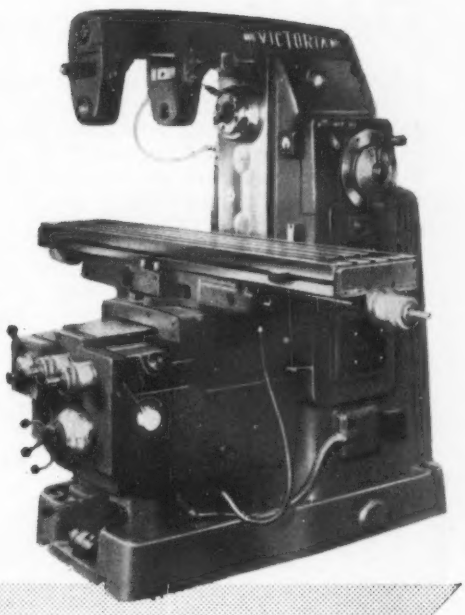

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18 rates of table feed in each direction.

12 spindle speeds, 22-1020 r.p.m.

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Spindle, feed and rapid traverse control by patent single lever 'Monotrol' unit.

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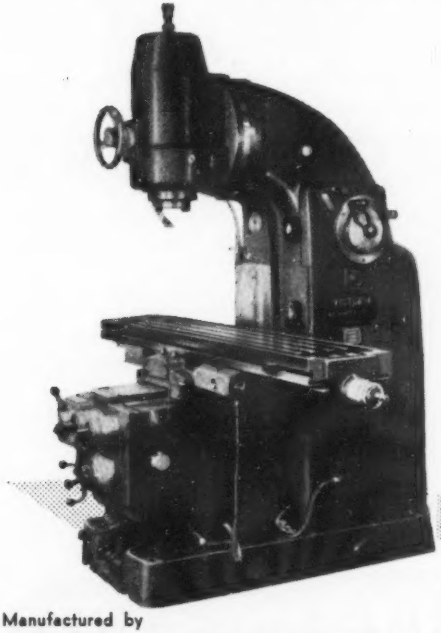

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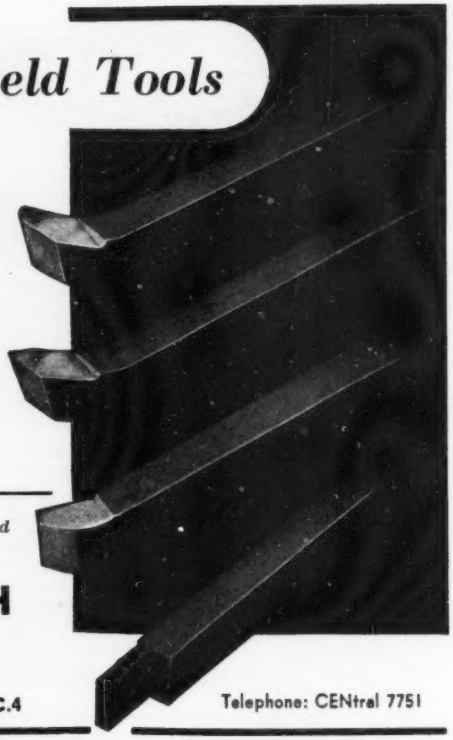

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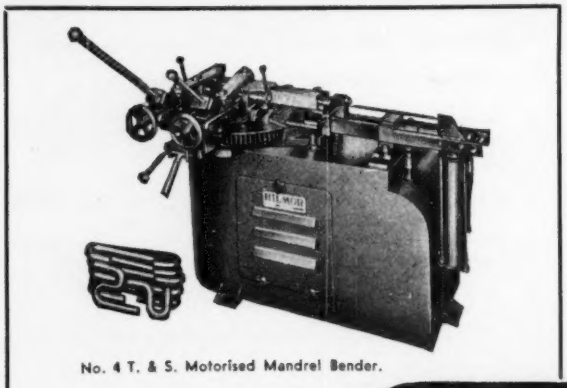

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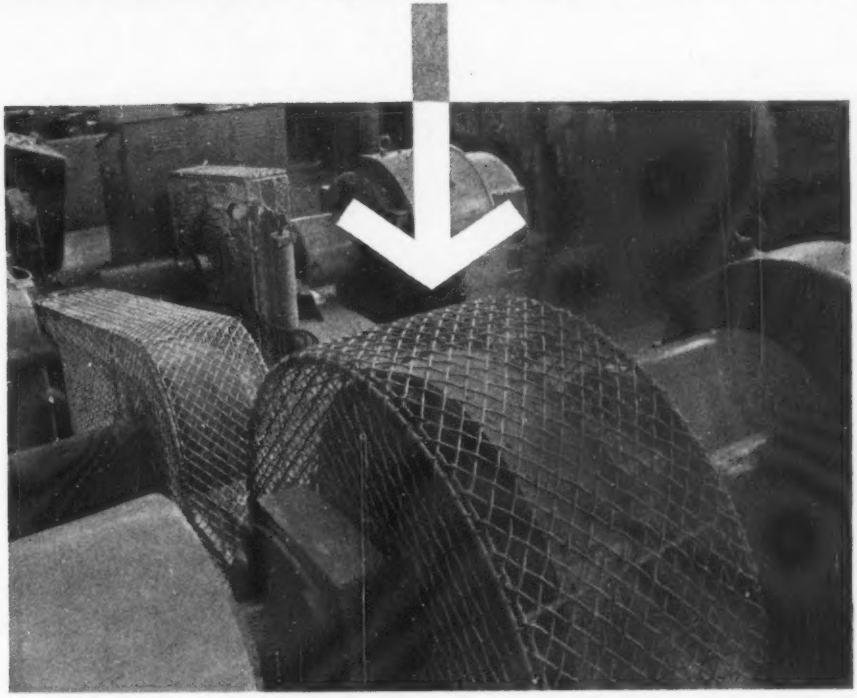

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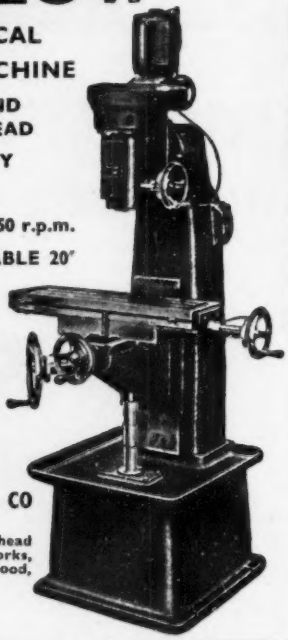

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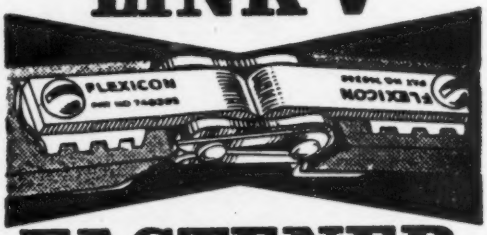

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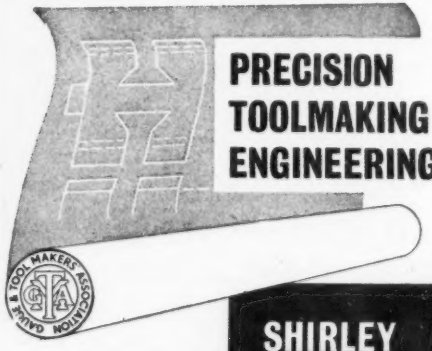

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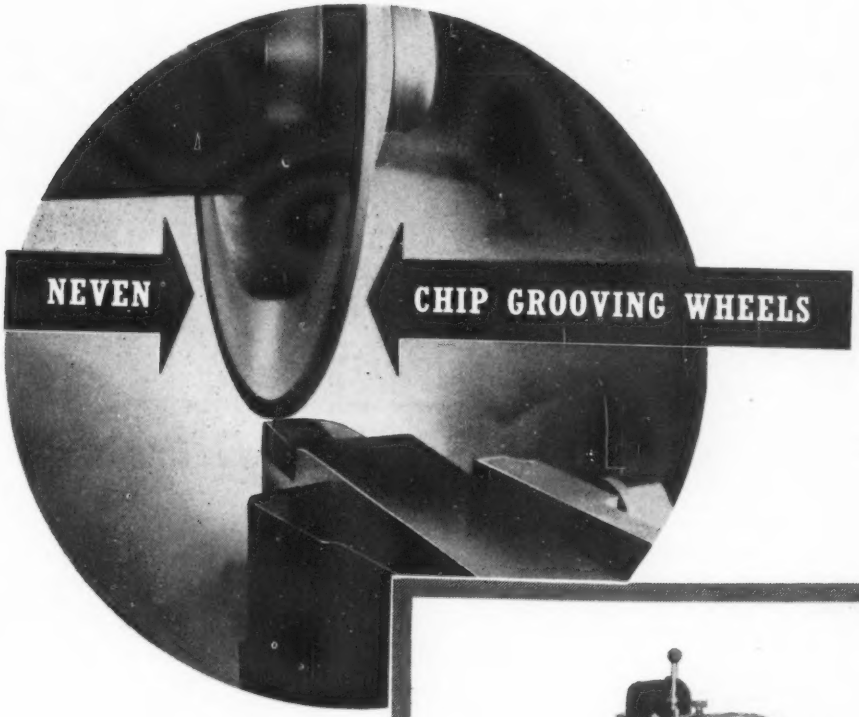

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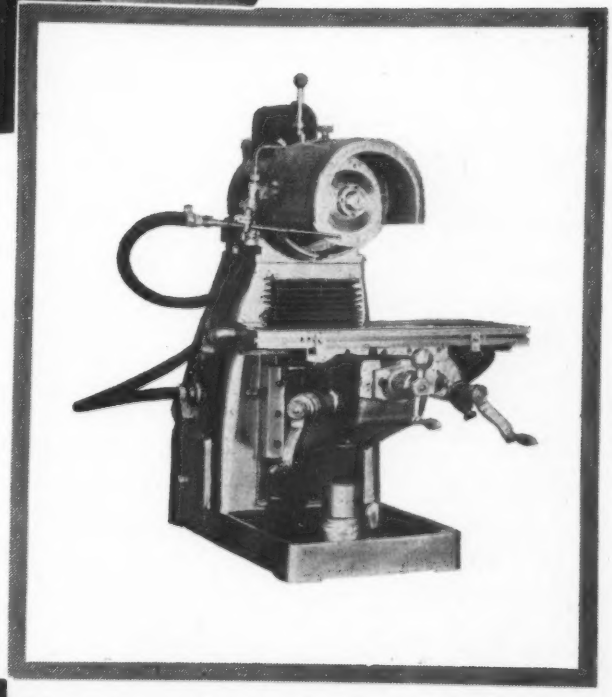

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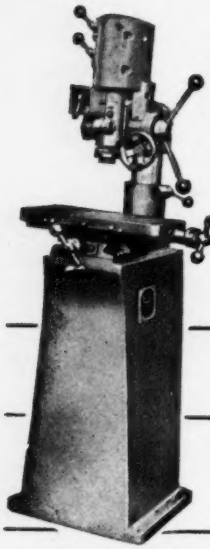

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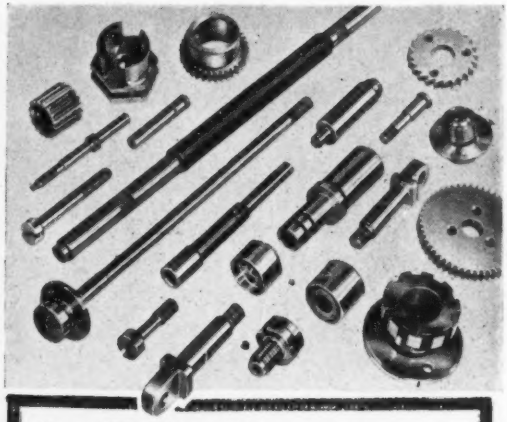

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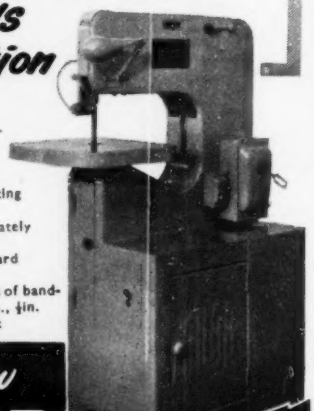

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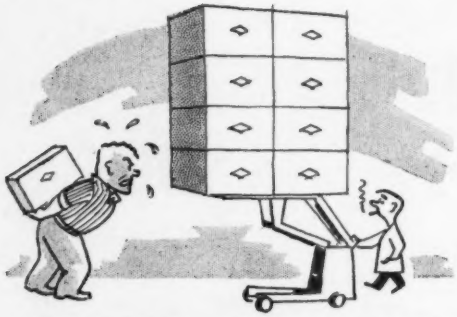

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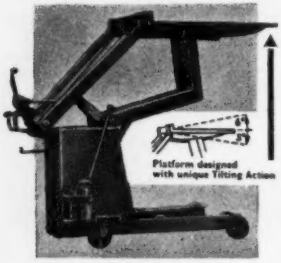

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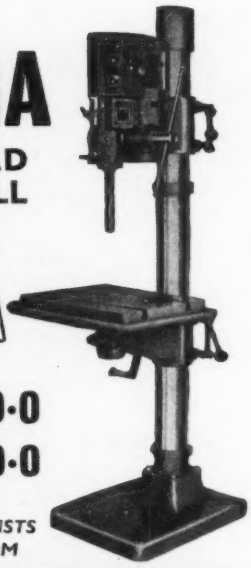

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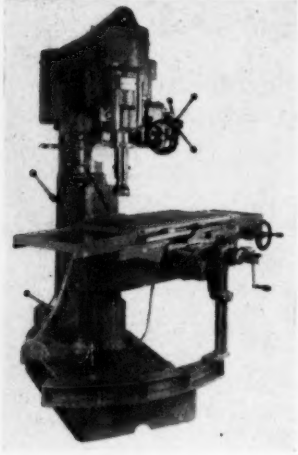

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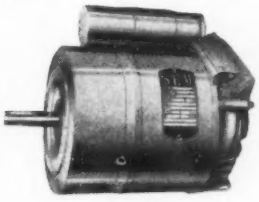

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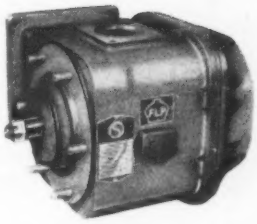

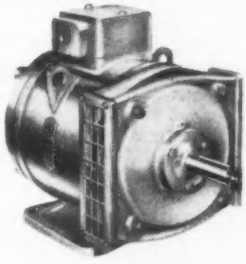

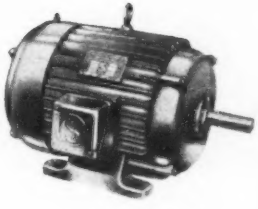

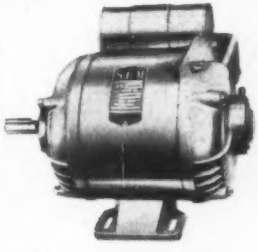

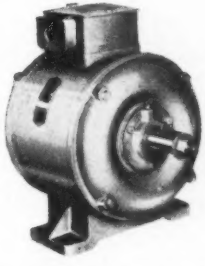

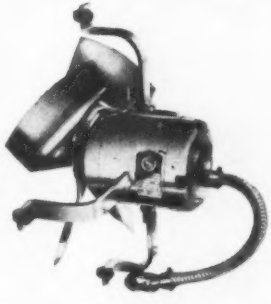

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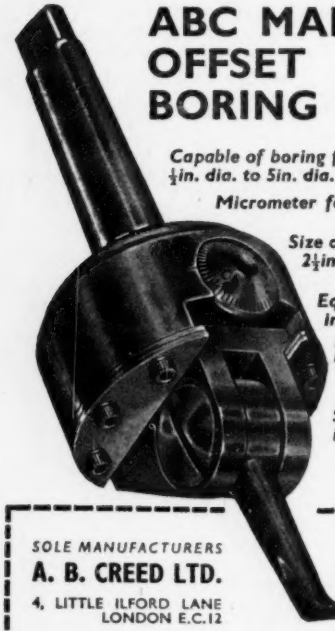

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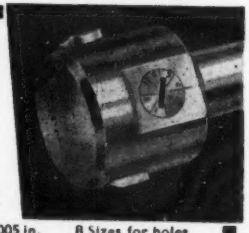

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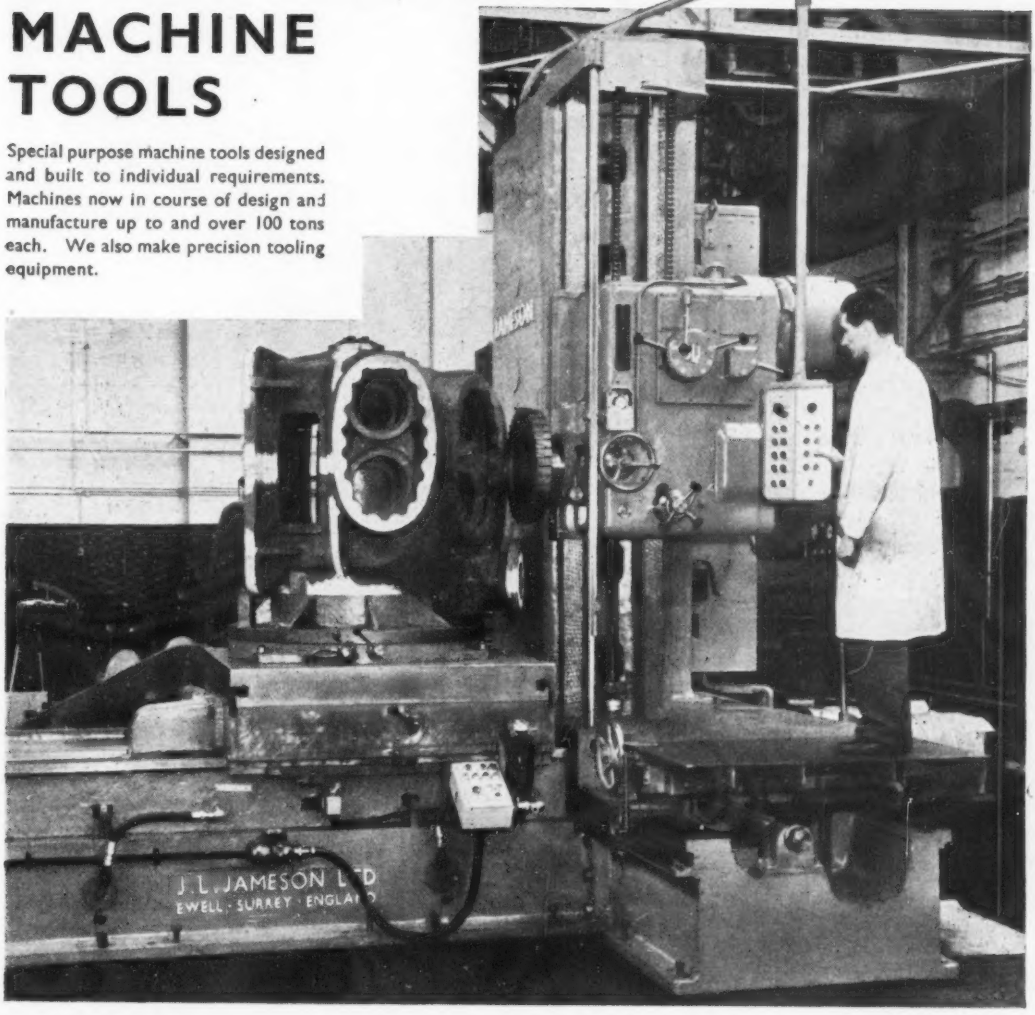

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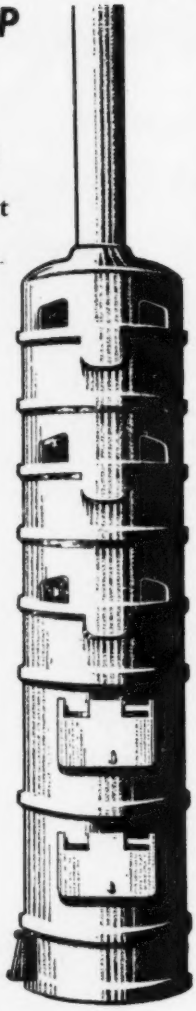

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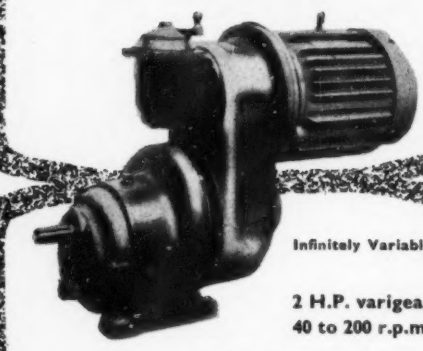

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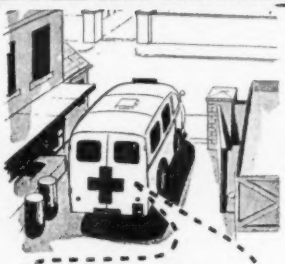

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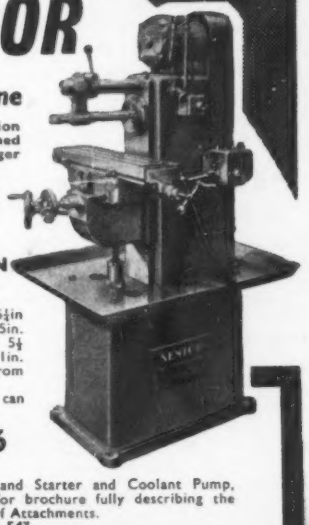

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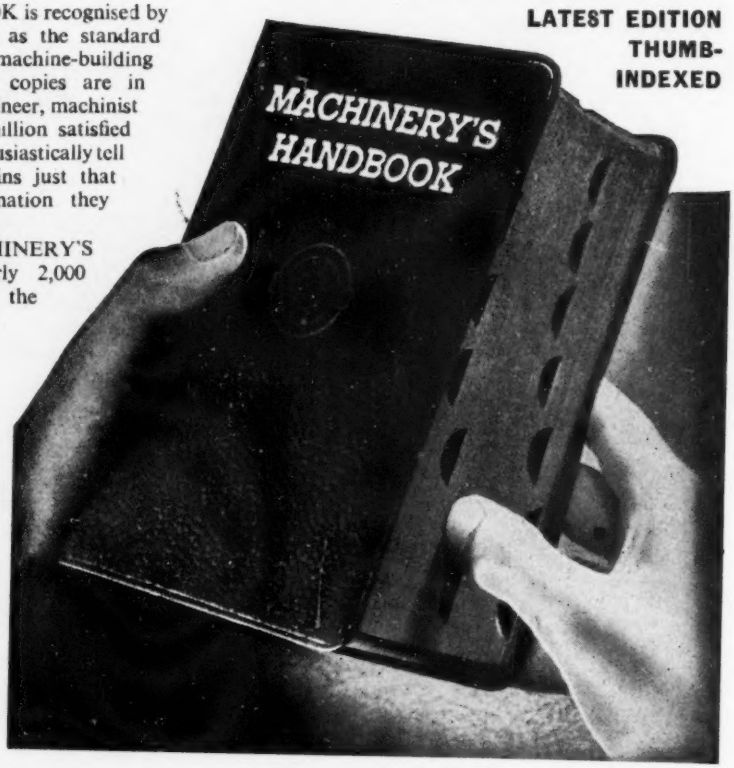

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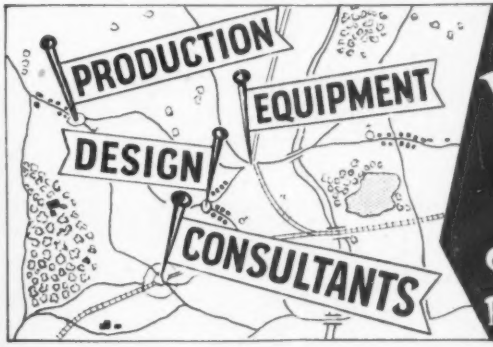

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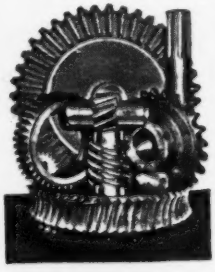

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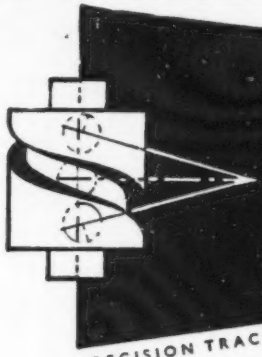

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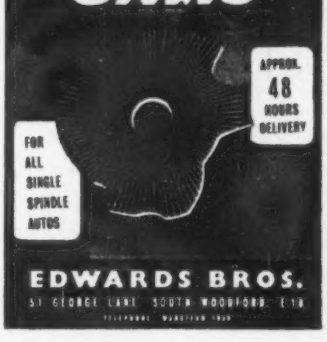

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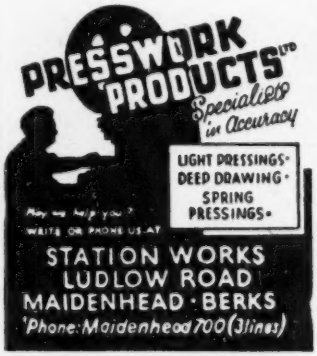

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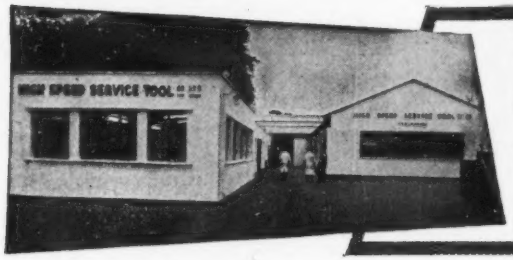

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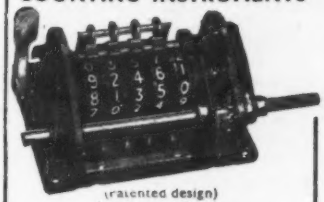
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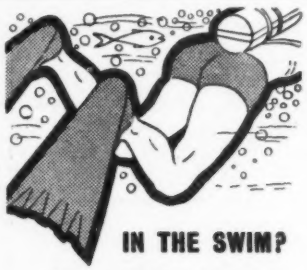

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Classified Advertisements (*PLANT FOR SALE, contd.*)

Cashmores

Selection of Machine Tools from Stock or Early Delivery.

DRILLING MACHINES

JONES & SHIPMAN 15in. Two and Three Spindle Drilling Machines, No. 3 Morse Taper spindles, motorised 400/3/50 cycles.
KITCHEN & WADE 4ft. 0in. Sensitive Radial Drilling Machine, two-motor type, box bed, motorised 400/3/50 cycles.

LATHES

NILES TIMESAVER 17in. Centre Heavy Duty Lathe, 13ft. between centres, swing 26in. dia. over saddle, motorised 400/3/50 cycles.
SWIFT 15in. Centre Heavy Duty Lathe, 8ft. 0in. between centres, swing 24in. dia. over saddle, motorised 400/3/50 cycles.
FAIRBAIRN 16in. Centre Heavy Duty Lathe, 15ft. 0in. between centres, swing 23in. dia. over saddle, motorised 400/3/50 cycles.
LANG 15in. Centre Heavy Duty Lathe, 17ft. 6in. between centres, 2 saddles, swing 19in. dia. over saddles, motorised 400/3/50 cycles.
WARD No. 7 Covered Bed Capstan Lathe, arranged chuck work, motorised 400/3/50 cycles.
New **MITCHELL** 12½in. Centre Gap Bed Lathe, admit 8ft. 9in. between centres, motorised 400/3/50 cycles.

HONING MACHINE

KITCHEN & WADE Vertical Hydraulic Honing Machine, capacity 2in. to 9in. dia bores up to 29in. long, motorised 400/3/50 cycles.

SLOTTING MACHINES

BUTLER 14in. stroke Slotting Machine, 30in. dia. indexed rotary table, motorised 400/3/50 cycles.
MUIR 30in. Stroke Heavy Duty Slotting Machine, 50in. × 50in. tilting table, motorised 400/3/50 cycles.

BORING MACHINE

WALDRICH Heavy Duty Vertical Turret Lathe, fitted side head, maximum swing 66in. dia., motorised 400/3/50 cycles.

GRINDING MACHINES

CHURCHILL Model VXA Vertical Spindle Hydraulic Surface Grinder, table 72in. × 16½in., segmental wheel 18in. dia., motorised 400/3/50 cycles.
LUMSDEN Model 91LE Vertical Spindle Rotary Table Surface Grinder, 26in. dia. table, grinding wheel 18in. dia., motorised 400/3/50 cycles.
CHURCHILL Model 08B Horizontal Spindle Hydraulic Surface Grinder, 30in. × 8in. table, motorised 400/3/50 cycles.
CINCINNATI No. 2 Centreless Grinder, Filmatic bearings, motorised 400/3/50 cycles.
NORTON 12in. × 36in. Hydraulic Universal Grinder, motorised 400/3/50 cycles.

PRESSES

BLISS 400 Ton Knuckle Joint Press, stroke 2½in., bed area 20in. × 20in., motorised 400/3/50 cycles.

MILLING MACHINES

ARCHDALE 30in. Vertical Dial Type Milling Machines, table 44in. × 14½in., motorised 400/3/50 cycles.
BOHLE Heavy Duty Dial Type Universal Miller, table 55in. × 14in., motorised 400/3/50 cycles.
ARCHDALE 18in. Horizontal Dial Type Plain Miller, table 30in. × 10in., motorised 400/3/50 cycles.

SHAPING MACHINE

STEPTOE 24in. Heavy Duty Shaping Machine, size of table 24in. × 16in. × 18in. deep. Motorised 400/3/50 cycles.

MISCELLANEOUS

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ADAMS U.S.A. No. 5 Horizontal Gear Hobbing and Thread Milling capacity, 10in. dia.; 49in. long.

JONES & SHIPMAN 138. 10in. × 27in, Universal Grinding Machine, good equipment.

CHURCHILL OSB 60in. × 8in. Hydraulic Horizontal Spindle Surface Grinding Machine, magnetic chuck.

CHURCHILL OSB 40in. × 8in. Hydraulic Horizontal Spindle Surface Grinding Machine.

CHURCHILL NB 18in. × 6in. Hydraulic Horizontal Spindle Surface Grinding Machine.

SWIFT 15½in. Centres Heavy Duty All Geared Gap Bed S.S. & S.C. Lathe, admit 10ft. between centres.

SWIFT 13in. Centres High Speed All Geared Gap Bed S.S. & S.C. Lathe, admit 6ft. between centres, speeds 8-800 r.p.m.

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MINGANTI Type 20-40P Hydraulic Pre-Selector Bar Feed and Chucking Capstan Lathe, fully equipped.

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MILWAUKEE 4H Heavy Duty Vertical Milling Machine, table 74in. × 15½in.

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38in. Radial Sensitive Drilling Machine, ARCHDALE No. 3 M.T.

10½in. × 6ft. Between Centres MITCHELL Centre Lathe.

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0/370	Bruce Peebles	0/220	0/1500	Drip proof
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0/200/200	G.E.C.	0/220	0/750/1000	Enc. ventilated
0/195/195	Harland	0/220	0/1100/1750	Drip proof
0/150	Met. Vick.	0/500	0/1500	Drip proof
0/150/150	L.S.E.	0/500	0/700/1600	Screen protected
0/120	G.E.C.	0/220	0/960	Screen protected
0/100/100	L.D.C.	0/220	0/750/960	Screen protected
0/73/73	Harland	0/480	0/1250/1550	Drip proof
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WINDLEY Master Surface Table, 4ft. 0in. × 3ft. 0in., on stand.

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10in × 36in. **CHURCHILL** Plain Grinder.
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WARD No. 7 Combination Turret Lathe, covered bed.
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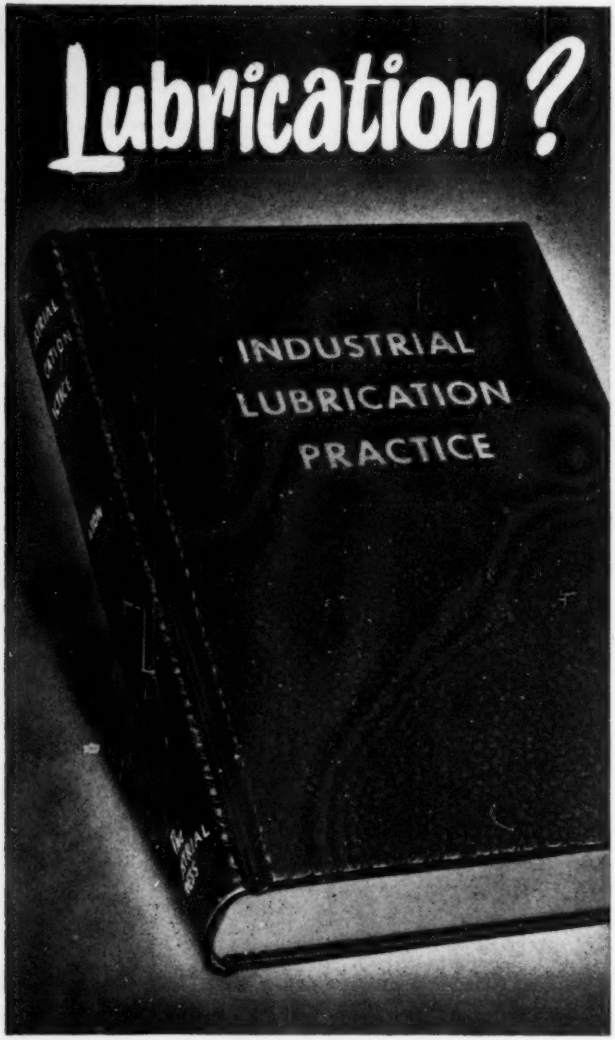

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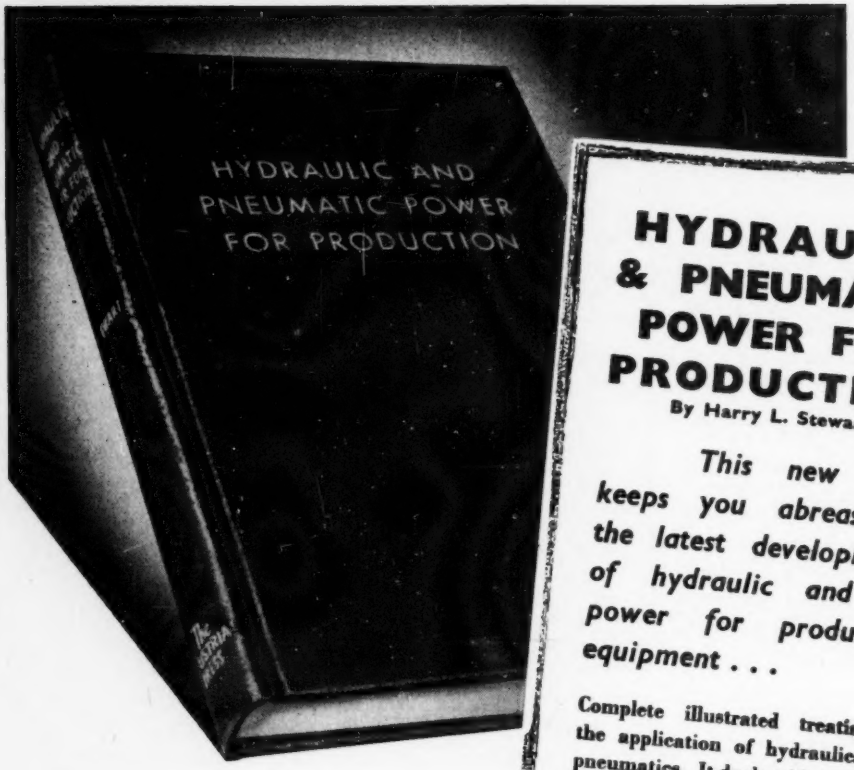

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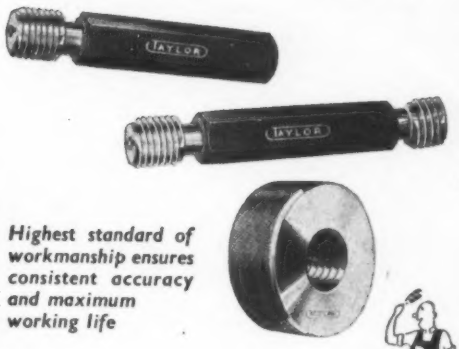

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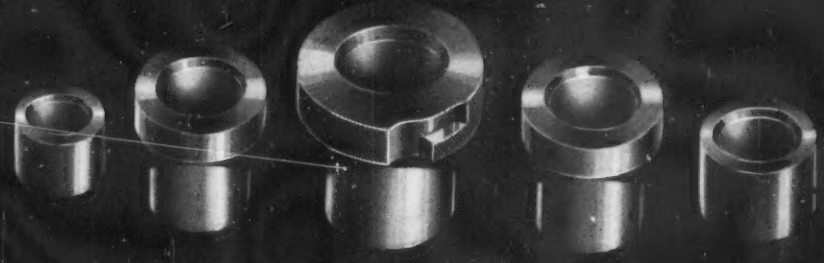

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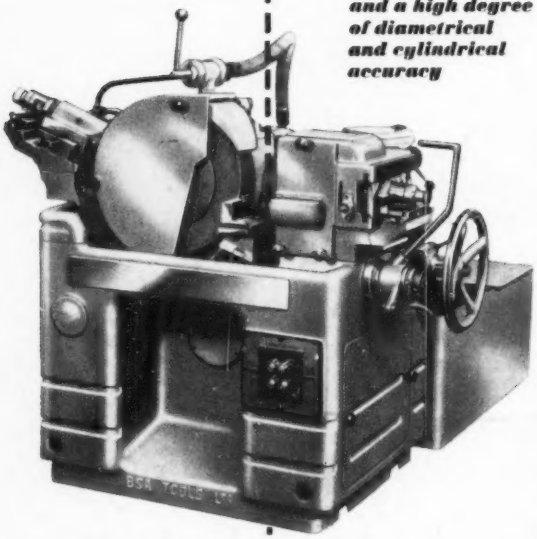

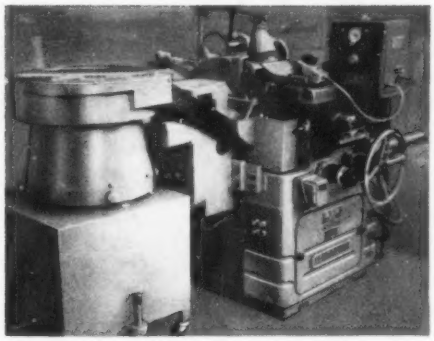

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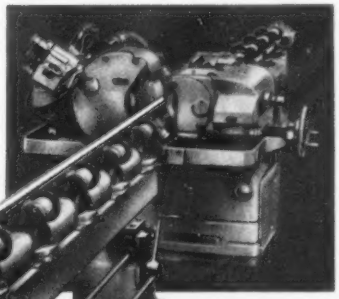

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